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DEPARTMENT OF MINES AND AGRICULTURE, SYDNEY.

RECORDS

OF THE

GEOLOGICAL SURVEY OF NEW SOUTH WALES.

VOL. V.

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CORRIGENDA.

Page 35, line 22. For *Mr. J. C. H. Mingaye, F.C.S.*, read *Mr. H. P. White, F.C.S.*
Page 90, line 14. For *X* read *IX*.
Page 93, line 30. For *Maitland (D. G.)* read *Maitland (A. G.)*.
Page 167, line 30. For *bead* read *beak*.
Page 181, line 3. For *Permo-carboniferous* read *Permo-Carboniferous*.

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Vol. V.] 1896. [Part 1.

I.—The Occurrence of Artesian Water in Rocks other than Cretaceous:* by E. F. PITTMAN, A.R.S.M., Government Geologist.

IN September last I reported the discovery of palæontological evidence proving that artesian water occurs in New South Wales in rocks of greater age than the Lower Cretaceous sediments to which it had hitherto been supposed to be confined, and the object of the present paper is to give a brief account of the facts referred to, together with some additional evidence gathered during a recent trip through parts of Queensland and New South Wales.

The railway now in course of construction between Narrabri and Moree passes over black soil plains, on which there is no permanent water supply which could be utilised for the locomotives, and it was an inquiry by the Railway Commissioners as to whether there were any prospects of obtaining artesian water at Woolabrar, on Dobikin Run, about midway between Narrabri and Moree, which led to my making an examination of this country.

The rocks penetrated by wells on the Dobikin Run were found to consist of white and grayish sandstones, bluish-gray sandy shales, brownish clays, and nodules of clay ironstone. A characteristic feature of these sediments was that they crumbled or became disintegrated freely on exposure to the atmosphere, owing, no doubt, to the quantity of water contained in them. In these rocks were found numerous plant impressions, among which *Tæniopteris Daintreei* (McCoy), a fossil plant characteristic of the Mesozoic Coal-Measures of Victoria, the Clarence River

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* Paper read before the Royal Society of New South Wales, 4th December, 1895.

Series of New South Wales, and the Ipswich Coal-Measures of Queensland, was readily recognisable. Another plant from this locality was identified by Mr. W. S. Dun, Assistant Palæontologist to the Geological Survey, as belonging to the genus *Baiera*.

Similar rocks were observed on the Terry-Hie-Hie Run, about twenty-five miles to the north-east; and still further north at an old shaft known as Moloney's Well, fourteen miles east of Moree, *Tæniopteris Daintreei* was again obtained. On arriving at Moree an examination of the drillings showed that, in their lithological characters, the rocks penetrated by the bore very strongly resembled those met with at Dobikin and Terry-Hie-Hie, and a subsequent examination of the contents of the core-box, in Sydney, enabled me to detect *Tæniopteris Daintreei* in one of the few solid pieces of rock which had been obtained by reaming; the greater part of the drillings having been extracted in a fine state of division, owing to the percussive action of the Canadian Drill.

The evidence thus obtained proves beyond doubt that the Moree Bore, which yields about three million gallons per day of artesian water of very good quality, is not in the Lower Cretaceous rocks, as was previously supposed, but in rocks of the same age as the Ipswich Beds of Queensland, the Coal-Measures of Victoria and the Clarence River Coal-Measures of New South Wales.

In subsequently examining the core-box from the Coonamble bore, I identified, in a solid piece of "reamings," a specimen of *Tæniopteris Daintreei*, and one of *Thinnfeldia odontopteroides* (Morris), another fossil-plant, characteristic of the Hawkesbury Series, which are regarded as homotaxial with the Clarence Series. The Coonamble Bore yields a supply of about 1,800,000 gallons of artesian water per day.

On January 20, 1894, a paragraph appeared in the *Daily Telegraph*, stating that the Rev. J. M. Curran had furnished a report to the Minister of Works to the effect that in his opinion the rocks pierced by the Coonamble bore were Triassic and not Cretaceous. Inquiries recently made at the Works Department elicited the reply that no such written report had ever been received from Mr. Curran; but I understand that Professor David questioned Mr. Curran at the time as to his reasons for supposing these rocks to be Triassic, and his reply was that although he had no definite palæontological proof of the age of the rocks, his opinion was based upon their lithological resemblance to those of the Dubbo District with which he was familiar, and upon the occurrence of a number of indeterminable plant-remains, similar to those common in the Dubbo beds.

In 1891, Mr. Robert Etheridge, Junr., identified a specimen of *Tæniopteris Daintreei* from the Nyngan Bore, and during the present year Mr. W. S. Dun recognised another specimen of the same fossil plant in some rocks forwarded by Mr. W. L. R. Gipps, from Terabile Creek, four and a half miles from the Castlereagh River.

It is clear therefore that a large portion of the area hitherto regarded as Lower Cretaceous, is in reality occupied by rocks of Triassic or Jurassic age, and it is also proved that these rocks are artesian water-bearing, and that they extend much further to the eastward than the eastern boundary of our artesian basin, as tentatively laid down on the Geological Map of the Colony. It may here be remarked that it is only by information derived from bores and wells, that the age of the underlying formations can be determined in most of the country hitherto referred to, for the reason that it consists of plains, the surface of which is covered by Pleistocene and recent deposits.

I have recently returned from a trip through part of Queensland and that portion of New South Wales lying to the north and north-west of Inverell, the object of my visit being to trace and map the eastern boundary of this newly discovered artesian water-bearing basin. I find that on the Dumaresq River (the northern boundary of the Colony) it passes about fifteen miles to the west of Texas, and I have, so far, traced it in a more or less south-westerly direction to the neighbourhood of Wallangra, the dip of the beds being to the west or south-west. If this boundary be assumed to continue so as to take in the Coonamble and Nyngan bores, it will easily be realised that a very considerable addition must be made to the area of the New South Wales artesian basin as hitherto shown on our Geological Map.

But if the discovery of artesian water in rocks of Triassic or Jurassic age be a matter of importance to New South Wales, it is, I think, of still greater importance to the Colony of Queensland. Mr. R. L. Jack, the Government Geologist of that Colony, and his Assistant, Mr. A. Gibb Maitland, were engaged during the year 1894 in mapping the outcrop of the basal or intake beds of the Lower Cretaceous basin of Queensland. They found these beds to consist of very porous (bibulous) marine sandstone, which Mr. Jack has named the "Blythesdale Braystone," and which he described in detail in an interesting paper read before the Australasian Association for the Advancement of Science at its Brisbane Meeting in January last.* The outcrop of this rock was traced from near Texas to Roma, following a more or less north-westerly course, but overlaid in places by the Desert Sandstone (Upper Cretaceous.)

The most southerly portion of this outcrop is described by Mr. Jack as differing somewhat from the typical Blythesdale Braystone as seen on the Weir River, and at Roma and other places further northward. The rock to the west of Texas is a gritty sandstone, and it contains cementing material, which appears to be absent from the typical Braystone; the latter is also, as a rule, much finer grained.

I have inspected the Braystone beds in the neighbourhood of Roma and Blythesdale, and I have also seen the sandstones fifteen miles west of Texas, and am strongly of opinion that the latter belong to freshwater beds of Triassic or

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* See also Artesian Water in the Western Interior of Queensland, Bull. Geol. Survey Q'land, 1895.

Jurassic age—in other words, to the Ipswich Measures, and not to the marine beds of the Lower Cretaceous (Blythesdale Braystones). I have, as already stated, traced these gritty sandstones without any sign of a break in their continuity, from the point fifteen miles west of Texas to Wallangra, and from the spoil heap of a well, ninety feet deep, twelve miles south-west of Yetman, I have obtained impressions of the fossil plant, *Tæniopteris Daintreei.*

In his paper read before the Australasian Association for the Advancement of Science, Mr. Jack describes the Blythesdale Braystones as the intake beds of the Cretaceous basin, but he adds that he strongly suspects they "may be reinforced by the agency of strata geologically on a lower horizon." He goes on to say, "till lately the best information available led me to the belief that the Trias-Jura formation, or Ipswich Coal-Measures, was succeeded conformably by the Lower Cretaceous or Rolling Downs formation, but in the last trip I have seen unmistakable evidence of an unconformability between them. It may be that the bibulous lower members of the Cretaceous rest directly on sandy members of the Ipswich Coal-Measures, which dip in the same direction. In this case the sandstone beds above the Toowoomba basalts, and the Murphy's Creek beds below, would feed the Blythesdale Braystones, and still further tend to equalise the supply by making good the loss entailed by the supposed connection of the latter with the ocean."

Up to the present time, however, no bores in search of artesian water have been put down in the Trias-Jura rocks of the Downs to the north-east of the line of outcrop of the Blythesdale Braystone. Two bores have been put down in the Ipswich Coal-Measures to the east of the Dividing Range, but neither of them was very successful. The site of one of these bores was Eagle Farm, near Brisbane Racecourse, and here an artesian supply of about 8,000 gallons of inferior water per day was obtained. The other bore was at Laidley, fifty-one miles west of Brisbane, and it did not result successfully so far as obtaining an artesian supply. It appears to me, however, that the positions of both these bores were unfavourable. The Coal-Measures at Eagle Farm appear to be, to all intents and purposes, isolated from the main body of the Ipswich Coal-Measures which underlie the Downs; for a large part of the City of Brisbane is built upon hills of palæozoic schists, against which the Coal-Measures thin out, and which act as a barrier between those on the east and those on the west of Brisbane; the Laidley Bore, also, does not appear to be favourably situated, when its altitude and that of the intake beds are taken into consideration.

With the country to the west of Toowoomba, however, the conditions appear to me to be very different.

Murphy's Creek Railway Station, to the east of Toowoomba, is seven hundred and eighty-eight feet above sea-level, and from there up to the top of the Dividing Range, near Toowoomba, are seen, at elevations increasing up to about 2,000 feet, outcrops of sandstones of the Trias-Jura formation, with some supposed interbedded lavas. Some of these sandstones are very porous, and are, therefore, well adapted to act as intake beds for artesian water. Their dip is to the west, under the Downs, at angles varying from 2° to 20°, and the rainfall over the area of their outcrop is high, being about forty inches per annum. Continuing now along the Western Railway Line we find that there is a gradual fall in the surface of the Downs, between Toowoomba and Roma, which is situated two hundred and seventeen miles further west. Thus, while the altitude of Toowoomba Railway Station is 1,921 feet, that of Roma is 978 feet.* The altitude of Gowrie Junction, only seven miles west of Toowoomba, is 1,577 feet, or only slightly more than that of Spring Bluff, where the porous sandstone outcrops.

It appears to me, therefore, that there is an area of country, having a width of about two hundred miles, and lying to the east of the outcrop of the Blythesdale Braystone, which, though hitherto unprospected, possesses all the conditions which are regarded as necessary to the occurrence of artesian water, and, in view of the recent discovery of a fine supply at Moree, in rocks of the same age as the Ipswich Coal-Measures, I am of opinion that the probabilities of artesian water being obtained in large quantities to the east of the outcrop of the Blythesdale Braystone are very strong indeed.

I have already quoted from Mr. Jack's paper, read before the Brisbane Meeting of the Australasian Association for the Advancement of Science, in which he drew attention to the porous nature of certain beds in the Trias-Jura formation, and to the probability of the water absorbed by them reinforcing the artesian supplies of the Lower Cretaceous formation. I not only concur in this opinion, but would even go so far as to suggest that the porous strata of the Trias-Jura formation may constitute the *chief* storage beds of the artesian water supply of Australia.

I am inclined to think that many of the successful bores in both New South Wales and Queensland may have obtained their artesian water, not altogether in the Lower Cretaceous rocks, but partly, and perhaps largely, in the underlying Ipswich Coal-Measures. Mr. Jack, in the interesting paper already quoted, speaks of unmistakable evidence of an unconformability between these two formations, and, in a sketch section, shows this unconformability to be so strong as to interrupt the continuity of the Trias-Jura formation; but, bearing in mind the very large area which the Ipswich Coal-Measures are known to occupy (with a more or less westerly dip) in the eastern portions of New South Wales and Queensland, and in view of the fact that at Leigh's Creek, near Lake Eyre, in South Australia, coal-bearing rocks have been identified by Mr. Robert Etheridge, Junior, as the probable equivalents of the Ipswich Coal-Measures*—I consider that there are good reasons for believing that these Triassic or Jurassic Coal-Measures may be *continuous* under the Lower Cretaceous basin.

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* Queensland Railways Time Table.

The occurrence of seams of coal in many of the artesian bores, both in Queensland and New South Wales, is also a matter which appears to bear upon the probability that, in many cases, sediments which have been regarded as Lower Cretaceous may really belong to the Ipswich Coal-Measures. So far as I am aware, the Rolling Downs formation in those localities, where *undoubted* sections have been examined, is essentially a marine deposit, and it appears more probable, therefore, that the coal-seams intersected in many of the bores, belong to the Ipswich beds, which we know to be coal-bearing, than to the Lower Cretaceous beds.

In the interests of geology it is is to be hoped that bores will soon be put down with drills capable of extracting a solid core, which would settle many of the vexed questions in connection with the geology of our Western Districts.

II.—Mineralogical and Petrological Notes, No. 4: by GEORGE W. CARD, A.R.S.M., F.G.S., Curator and Mineralogist.

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11. Rocks from the Yulgilbar Cinnabar Mines.
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13. Rocks from the Cox River.
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* Reports on Coal-bearing Area in Neighbourhood of Leigh's Creek, by H. Y. L. Brown, Adelaide, 1891. By Authority, p. 12.

1. *Magnesian alum-Pickeringite-from Capertee, and the Shoalhaven District.*—A magnesian alum from Mount Victoria, was recently referred to in these Records.[*] These all agree in consisting of aggregations of bundles of delicate silky fibres. The Shoalhaven mineral is described as occupying cracks in sandstone.

	1[†]	1A	2[‡]	A
Water (by difference)	45·79	**46·49**	42·37	**43·12**
Insoluble matter	1·51	....	1·74	....
Alumina (Al_2O_3)	7·14	**7·25**	10·91	**11·10**
Magnesia (MgO)	9·03	**9·16**	4·68	**4·76**
Potash (K_2O)	·32	**·32**	1·06	**1·07**
Soda ($N^d{}_2O$)	·53	**·53**	trace	trace
Sulphuric anhydride (SO_3)	35·68	**36·23**	38·14	**38·82**

1. Capertee. Analysis by Mr. J. C. H. Mingaye, F.C.S.

2. Shoalhaven. Analysis by Mr. H. P. White, F.C.S. This also contains ferric oxide, 0·21, lime, 0·30, manganous oxide, 0·59, and traces of the oxides of copper, nickel, and cobalt, and of chlorine.

1A, 2A. Percentage composition of the soluble portion of 1 and 2 respectively.

While the percentage of the magnesia in the Shoalhaven is normal, that from Capertee is unusually high.

Magnesium alums have been recorded under various names from the Cape Verde Islands, Chili, and elsewhere. It seems likely that some at least of these minerals are not homogenous.

2. *Tetradymite (?) from Tamworth.*—In August, 1894, Mr. G. A. Stonier, Geological Surveyor, collected some specimens of quartz from Moor Creek, Tamworth. These contained visible gold associated with a steel-gray mineral occurring in thin plates. The mineral is very soft, marking paper like graphite, and has a highly metallic lustre. The presence of tellurium and bismuth could be detected, but a quantity sufficient for analysis could not be obtained. The quartz is in part glassy and ironstained, and in part dull and dark green in colour, due to the presence of chloritic matter.

Tetradymite, together with its alteration product, montanite, has been recorded[§] as occurring in an ironstone gossan near Captain's Flat.

3. *A Diamond having the form of the Cube from South Africa.*—This was received by a Sydney diamond merchant in a parcel of "bort," and was acquired for the Mining Museum. The edges of the cube ($\infty O \infty$) are modified by a series of overlapping faces of the octahedron (O), giving rise to an appearance of a bevel such as would result from the presence of the rhombic-dodecahedron (∞O).

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[*] Vol. iv., Pt. III, p. 133.

[†] 95/2443.

[‡] 96/3022.

[§] Rec. Geol. Surv. N. S. Wales, 1889, I., pp. 20-30.

The diamond has a grey tint; it measures 5 mm. in length of edge, and weighs 3·32 carats. There appear to be but few cases on record of a diamond having this form. Prof. G. F. Kunz has referred* to some Brazilian diamonds having the form of the cube. One of these had a diameter of four millimetres. Two were made up of a series of eight cubes aggregated together like a bale of cotton; others showed faces of the hexakis octahedron (**mOn**.)

4. *Stolzite and Nantokite from Broken Hill.*—This comparatively rare mineral, a tungstate of lead, is now being found in at least two different forms. One variety is of a gray colour, with a pearly lustre, and resembles the head of a nail in appearance; the crystals consisting of faces of the tetragonal prism terminated by a low pyramid of the same order.

The other variety is found apparently only in the Open Cut at the Proprietary Mine. It is yellow-brown in colour, and the crystals consist essentially of the tetragonal pyramid. The basal plane and a pyramid of different order are sometimes present. One of the largest crystals has a length of nearly a centimetre.

A massive form of stolzite, intimately associated with scheelite and cuproscheelite, occurs at Peelwood.

Nantokite (Cuprous choride) has been described† by Prof. A. Liversidge, M.A., F.R.S. The oxidation of this mineral to atacamite (oxy-chloride of copper) is very rapid. Attempts were made to retard this action by saturating the specimens with paraffin wax, and sealing up in glass-capped boxes. This has only been partially successful.

5. *Crystallised Gold from Grong Grong.*—Some ferruginous quartz from Grong Grong shows gold finely dusted over the surface. On examination with a powerful pocket lens this "dust" is seen to consist of individual crystals. Under the microscope many of these crystals are seen to have been damaged by friction against other specimens. Their average size would be, approximately, somewhere about one-twentieth of a millimetre. The crystalline form has not as yet been satisfactorily made out; but faces of the cube, the rhombic-dodecahedron, and of the octahedron appear to be present.

6. *Antimonial and Arsenical Silver Ores from Armidale.*—These ores have hitherto been known to occur at Rivertree, near Drake, and then only in very small quantities. They have now been found in veins and patches of considerable size associated with arsenical pyrites and blende in the vicinity of Rockvale, Armidale. The antimonial varieties would appear to predominate over the arsenical, only one specimen of proustite having been received up to the present. Stephanite is said to occur, and a small specimen resembling somewhat the polybasite of Mexico, but containing no copper, is probably that mineral. The occurrence of crystallised specimens has not yet been recorded.

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* Quoted in the Engineering and Mining Journal for 18th Sept., 1886.

† Min. Mag., 1894, X, p. 326.

Two specimens of massive arsenical pyrites, in which the silver minerals could not be readily detected, were found to contain, respectively, seven hundred and seventy-nine and eight hundred and sixty-two ounces of silver to the ton. Two other specimens, in which pyrargyrite was freely visible, yielded respectively, on assay, silver at the rate of 1,885 oz. and 2,341 oz. per ton.

Lumps of pure pyrargyrite of considerable size have been found. Native silver occurs in the form of spongy masses made up of delicate filamentous growths, and also as thin encrustations.

7. *Trachytic Tuff from the Manning River District.*—This [745] is an earthy white rock containing numerous crystals of sanidine, and enclosing angular fragments of shaly material. The sanidine crystals are numerous, but small—up to 5 mm. in length—and are of the usual tabular habit. The included fragments vary in size from half an inch downwards.

Under the microscope the sanidine crystals are seen to be idiomorphic, but somewhat corroded. They contain a variety of inclusions, and have a tendency to assume orthopinacoidal sections. The base is dusky and spotted. Examined under high powers, it is seen to consist of dusky particles and wisps and shreds of glass.

Trachytic rocks have, up to the present, been recorded (in New South Wales) only from the Warrumbungle Mountains*.

8. *An Acid Tuff from Rudder Hill, Macleay River.*—This [622-3-4] is a compact gray rock, weathering brown and white. With a lens of low power, it is seen to contain numerous angular fragments of colourless translucent quartz. A polished surface reveals various shades of gray, and, in addition to the quartz grains just alluded to, numerous specks of pyrites and angular included fragments of considerable size. Some of these inclusions are lighter, others darker, than the ground-mass. One of the larger fragments measures twelve millimetres by nine. Bands and patches of a lighter colour occur in the ground-mass.

Under the microscope the included fragments are found to consist of quartz, devitrified glass, and to a less extent of crypto-crystalline volcanic rocks.

The specific gravity of an unweathered chip, determined by the Joly Balance, is is 2·75.

9. *Rocks from Binalong.*—A series of four rocks collected by Mr. J. E. Carne, Geological Surveyor, early in 1894.

[497] A *quartz-diorite* consisting of hornblende, striped felspar, and quartz. Much of the hornblende is idiomorphic, both green and brown varieties being present. Secondary outgrowths of clear material surround most of the felspar, the original portion of crystals being converted into kaolin, epidote, &c. Quartz is fairly abundant.

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* These Records, Vol. IV, Pt. III. The Trachytic Rock therein described has been proved by Prof. T. W. E David to be a silicified portion of a crystal-tuff.

The remaining rocks—[494-5-6]—consist of devitrified *felspar porphyries.* Corroded crystals of quartz and felspar are embedded in a more or less felsitic matrix. Hornblende is absent, the ferro-magnesian constituent being biotite—much corroded, and to a large extent recrystallised. The ground-mass is completely micro-crystalline, much of it appearing as a water-clear mosaic between crossed nicols, and has a general brownish tint due to the development in it of flakes of mica.

The felspar is tolerably clear, zoned, and is mostly, if not entirely, plagioclase. The phenocrysts are surrounded by a clear space in the matrix. Quartz in secondary aggregates and magnetite in the biotite are also present.

In places the base exhibits a curvilinear appearance outlined with flakes of mica. There can be little doubt that this represents an original perlitic structure.

10. *Rocks from the Coramba Gold-fields.*—Coramba is situated some twelve miles westerly from Woolgoolga, in the Grafton District. The rocks now briefly referred to were collected by Mr. J. E. Carne, F.G.S., Geological Surveyor, in November, 1895.

The country rock [736], exemplified by specimens from Tallawudjah, is a compact buff-coloured sedimentary rock, consisting of sub-angular fragments of quartz and felspar set in a yellowish matrix.

The remaining samples consist of granites and, perhaps, porphyries, presumably intrusive in the country rock.

[740] is a crushed *granite* consisting essentially of fractured or comminuted quartz and felspar. Much of the felspar exhibits lamellar twinning, and in some of these the twin lamellæ are bent, or faulted so as to resemble nothing so much as a section in miniature through a Belgian Coal-field.

Macroscopically, the rock has more the appearance of a crushed felsite. From the Evening Star Claim is a somewhat similar rock [739]. In hand-specimens of these the constituent minerals are not readily recognised. This is different, however, in the case of a rock from the Coramba King Mine [738]. This rock has more the appearance of a porphyry; crystals of dead-white felspar and blebs of glassy quartz being embedded in what appears to be a greenish felsitic base. The internal evidences of crushing are much less marked than in the rocks already referred to. A little brown hornblende is present; and this has been stretched and disrupted by crushing.

[737] From the Lady Elsie Claim is a more or less fissile rock resembling [738].

11. *Rocks from the Cinnabar Mines, Yulgilbar, near Lionsville.*—The notes refer to rocks collected by Mr. J. E. Carne, F.G.S., Geological Surveyor, in October, 1895.*

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* See forthcoming Ann. Rept. Dept. Mines for 1895.

[733, 734] From No. 2 Shaft. Fine-grained *augite-diorites.* Compact dark-green pyritous rocks, apparently having a slight tendency to fissility.

The minerals present are tolerably clear felspar, showing lamellar twinning; pale-green hornblende with a tendency to develop idiomorphic crystals on the one hand, and ophitic structure with regard to the felspar on the other; chloritic products resulting from the alteration of hornblende; a little colourless granular augite; magnetite developing in the hornblende which is somewhat bleached in consequence.

[734] Country Rock. *Granitite* (of G. Rose). Quartz; felspar—orthoclase and repeatedly twinned varieties (oligoclase probably); a little hornblende; a very little magnetite.

The larger felspar crystals are very clearly zoned; they are somewhat altered. The hornblende is more or less idiomorphic.

[744] This would appear to be identical with [734]. The constituents are, however, very much weathered; and this alteration has been accompanied by an introduction of cinnabar. This mineral occurs in scattered grains in the felspars, and in more or less continuous strings in the hornblende following the divisional planes.

[735] A compact greenish-coloured *felsite* weathering brown.

[741] Pyritous *felsite* with secondary quartz, calcite, and cinnabar. From No. 2 Shaft.

[742] From fifty-foot level; similar to [741].

12. *A Peridotite from Gundagai.*—This note has reference to a specimen [620] collected at the "Emu" chrome-iron ore mine at Gundagai, by Mr. J. E. Carne, F.G.S., Geological Surveyor, in 1895. At that particular mine the peridotite would appear to constitute the matrix in which the ore occurs. Macroscopically the rock is dense, tough, and of a blackish-green colour, translucent in thin splinters (and green by transmitted light). On the joint faces that bound the specimen is a coating of smooth reedy serpentine. Here and there are visible faces of a fibrous mineral not differing much in colour from the mass of the rock. Under the microscope the rock is found to consist of fresh *olivine* traversed in all directions by thin veins of a pale yellowish-green limpid *serpentine* quite free from magnetite. Accompanying the olivine is a *rhombic pyroxene* which is passing into the *bastite* modification, *chrome spinel,* and (probably) *chromite.* The pyroxene occurs in massive colourless crystals; prismatic cleavage is ill-defined, pleochroism is feebly indicated by a variation in illumination when rotated over the lower nicol, extinction is parallel to the trace of the pinacoidal cleavage, refractive index high, double refraction weak and apparently positive. The development of bastite has gone on more especially in the vicinity of transverse cracks to which the

fibres are set at right angles. Between crossed nicols much of the pyroxene is seen to possess a lamellar structure, a series of narrow, parallel (straight or curved) bands, sometimes consisting of drawn-out lenticles, extinguishing at a different angle to, and sometimes polarising in more vivid colours than the crystal. The extinction angle of the lamellæ is in some cases very oblique. There would thus appear to be an intergrowth of pyroxenic minerals, a nonoclinic variety being represented by the obliquely extinguishing lenticles. Although satisfactory cleavage flakes could not be obtained for examination in convergent light, the mineral may perhaps be regarded as *bronzite* in which a change to *bastite* is in progress.

Consisting as it does of olivine with some rhombic pyroxene and a little spinellid, the rock can be best classed as a peridoxite. It is of interest as being apparently the first unaltered representative of this group to be recorded as occurring in New South Wales. Its dense compact nature renders its appearance very distinct from that of the now well-known olivine-rock, dunite, from New Zealand. The occurrence of peridotites at the Gundagai Chrome Mines points to the probability of the serpentines and chrome deposits of this district having originated in what is generally regarded as the normal way—from olivine; a point of interest in view of the clear evidence now being collected[*] by my colleague, Mr. J. B. Jaquet, A.R.S.M., F.G.S., that the serpentines of some other districts of New South Wales, and among others the chrome-bearing serpentines of Berthong in the Wallendbeen District, have originated mainly if not entirely from amphibole.

13. *Rocks from the Cox River.*—A series of six intrusive igneous rocks collected from the bed of the Cox River, below Hartley, by Mr. H. G. Rienits and Mr. Clive Ball, to whom is due the description of the mode of occurrence of the rocks. On striking the Cox River one mile below Littleton Homestead, a few miles west of Hartley, the rock is a grey granite [638], traversed in a north-east and south-west direction by a vein of tourmaline from one to four inches thick. In about fifty yards this is replaced by a pink aplite [640], traversed by veins of pegmatite containing tourmaline [641]. Two hundred yards further on is a pinkish felsite [642] extending for about half a mile. The felsite contains balls of granite from one to three inches in diameter; these weather out, leaving globular cavities. A quartz-diorite [643] succeeds the felsite, and extends for a quarter of a mile. After passing over a hard sedimentary rock with fossiliferous bands for some two miles the quartz-diorite [645] again crops out, and an east to west dyke of that rock has given rise to various secondary minerals—wollastonite, garnet, quartz—by contact metamorphism in the country rock. Graphic granite [616] is met with still further on.[†]

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[*] Geology of the Broken Hill Lode. Sydney, 1894, p. 58.

[†] Since writing this description the Writer has paid a brief visit to the locality under the guidance of the above-mentioned gentlemen. The distances given must be regarded as very approximate. The fossiliferous rock is quartzite of Devonian age, and may, perhaps, be regarded as an easterly extension of the Mount Lambie beds. The Geological Survey is much indebted to Mr. Rienits for much valued assistance.

The diorites, especially perhaps [643], are more typical representatives of their class than most of those generally known to occur in the Colony, and should be useful for educational purposes.

[638.] May be described as a rather basic *granite.* The minerals present are quartz, much white and pinkish-white felspar, biotite, sphene, apatite, and magnetite. Some of the felspar is triclinic. Small crystals of sphene can be detected by the unaided eye.

[640.] A fine-grained granulitic pinkish *aplite*, consisting of quartz and felspar (some triclinic) with a little mica. A micro-graphic structure is present.

[641.] *Pegmatite* with much pink felspar and black tourmaline (schorl); a little mica is also present. This occurs as veins in [640].

[642.] Pinkish *felsite* consisting of small phenocrysts of quartz and felspar in a thoroughly devitrified base. Between crossed nicols the mosaic-like base can be readily resolved into its constituents.

[643.] *Quartz-diorite,* consisting of felspar, green hornblende (sometimes with a bluish tint), a little quartz, and sphene occurring in minute crystals scattered abundantly through the rock, and contained by the hornblende. Pyrites occurs as a secondary mineral associated with the hornblende.

[645.] *Quartz-mica-diorite,* not quite so fine-grained as the preceding, and without sphene. Much of the felspar is beautifully zoned. Apatite is abundant. The biotite would appear to have developed to some extent subsequent to and at the expense of the hornblende.

14. *Norite from Wyalong.*—Among the rocks collected from the Wyalong Goldfield on two successive visits by the Government Geologist are two which from their silica content and mineral constituents must be classed as *hypersthene-gabbro* or *norite.* The bulk of the rocks collected consist of gneissic granitites, diorites, and quartz-diorites, and a general description of these will shortly appear in these Records. Meanwhile it is desirable to record the occurrence of this interesting rock. The norite is a medium-grained dark-gray rock, having a specific gravity of 2·76*, and a silica percentage of 50·60*. The minerals present are *plagioclase felspar, hypersthene, hornblende, magnetite, zircon, apatite,* and probably *quartz.* The felspar which is fresh and abundant has not yet been determined. Twinning is almost entirely on the albite type; and the felspar is to some extent schillerized. Hypersthene is very representative, exhibiting the characteristic pleochroism, cleavage, outline, and straight extinctions. A paramorphic (?) change to hornblende can be traced step by step from a peripheral fringe of fibrous material to crystals of hornblende containing residual hypersthene and, by inference, to hornblende in

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* Determined respectively by Mr. M. Morrison and Mr. H. P. White.

which the transition is complete. There would appear to be a close analogy between the changes here referred to and those described by Williams and Chester in the norites of Baltimore and Delaware respectively. The hyperstheme is traversed by deeply-stained cracks. The hornblende is generally green in colour and exhibits well-developed cleavage cracks when of appreciable mass. It is probably entirely secondary.

III.—Palæontologia Novæ Cambriæ Meridionalis.—Occasional Descriptions of New South Wales Fossils, No. 2 : by R. ETHERIDGE, Junr., Curator of the Australian Museum.

(*Continued from Vol. IV., Pt. I, p.* 37.)

[Plate I.]

1. *Genus* PLATYCERAS, *Conrad.*

THE species of this very protean genus have been variously grouped and arranged by authors, either in structural groups, such as *spinosi*, *annulati*, &c.; as sub-generic sections under the genus in chief, or as the latter in the light of genera pure and simple.

As sub-generic sections the chief are:—

a. PLATYCERAS, Conrad (= *Acroculia*, Phill.)—Apex incurved or spirally coiled; surface concentrically striate, radiately plicate, or spiniferous.

b. ORTHONYCHIA, Hall.—Shell arched or straight, elongately conical; the apex recurved but not spiral or enrolled; surface concentrically striate.

c. IGOCERAS, Hall.—Resembling *b*, but the surface cancellate.

d. EXOGYROCERAS, Meek and Worthen.—Shell with a sinistral coil, and an obscure columella.

These sectional divisions are only of use in extreme forms, as it is often difficult, remark Messrs. Meek and Worthen, to separate them, owing to gradations by which they blend into one another.*

Four species have been described from the Permo-Carboniferous rocks of New South Wales, two by Dana, and two by De Koninck. Both of Dana's (*Pileopsis tenella* and *P. alta*), as he termed them, are difficult of determination from their comparatively small size; while De Koninck's species are European forms recognised as Australian—*Platyceras augustum*, Phill., and *P. trilobatum*, Phill. The first of these is a synonym of *P. auricularis*, Martin, and the second of *P. vetustus*, Sby, and both appertain to the section *Platyceras* proper. As regards Dana's specimens, one (*P. tenella*) is an abnormally depressed form for this genus; the other (*P. altum*), referable to the section *Orthonychia*, I believe I have recognised in a fossil collected by Mr. John Waterhouse, M.A., and presented by him to the Collection.

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* Illinois Geol. Survey Report, 1868, III, p. 387.

Platyceras (*Orthonychia*) *altum*, Dana?

Pl. I, Figs. 1 and 2.

Pileopsis alta, Dana, Wilkes' U.S. Explor. Expd., 1849, x. (Geology), p. 706, Atlas, t. 9, f. 14.

Sp. Char.—Shell cornute and much curved, acuminate above, non-lobate, and laterally compressed; height slightly greater than the antero-posterior diameter of the mouth; sides flattened; apex acute, much re-curved and inclined downwards, overhanging, central to the general plane of the shell, or excentric; anterior outline convex and strongly curved; mouth elliptical, in one plane, antero-posterior diameter rather more than one-third greater than the transverse; peristome entire, without sinuosity or expansion, the anterior margin rounded, lateral margins almost straight, and the posterior very slightly truncate. Surface with concentric laminations of growth, with intermediate fine striæ, crossed by the finest possible continuous striæ in the direction of the growth.

Obs.—In consequence of the small size of Dana's *P. altum*, it is difficult to surmise whether the present fossil, represented in Pl. I Figs. 1 and 2, is that species or not, a difficulty not lessened by the known variability of the species of the genus. However, if the degree of curvature of the shell can be accepted as any criterion, I think that Pl. I Figs. 1 and 2, may be accepted as *P. altum*, Dana, although it may be pointed out that the apex in the latter is not bent downward to the same extent as in the specimen now under description. At the same time one fact may be noted in favour of the view now adopted, both come from the same locality and horizon.

Loc. and Horizon.—Harper's Hill, near West Maitland, and Rutherford, three and a half miles from West Maitland; Lower Marine Series, Permo-Carboniferous. Collected by Mr. J. Waterhouse, M.A., and presented by him to the Mining and Geological Museum, with the succeeding specimens.

Platyceras (*Orthonychia*) *cornu-capella*, sp. nov.

Pl. I, Fig. 3.

Sp. Char.—Shell cornute, narrow, more or less curved, acuminate above, laterally compressed; height equal to the antero-posterior diameter of the mouth; apex acute, but not overhanging as in the last species, apparently in the central line of the shell; anterior outline convex, curved; mouth elliptical, in one plane, antero-posterior diameter nearly double the transverse; anterior outline convex, curved; front narrow, the margin rounded; sides flattened, with rather straight margins; posterior slope flattened, the outline somewhat concave, and the margin slightly truncate; surface bearing subangular somewhat gradate concentric ridges, with concave interspaces, both traversed by concentric fine striæ, and crossed by other microscopically fine striæ in the direction of growth.

Obs.—Although there are well marked points of difference between this and *P. altum*, Dana, such as the gradate concentric ridges, much longer mouth fore and aft, and a less bent down apex, it is possibly only a variety of that species, for reasons already explained. It accords rather better with De Koninck's figure[*] of *P. altum*, than it does with Dana's, and I therefore prefer, for the present at least, to consider it distinct, this being, I believe, the safer course. Both this and the last species described are remarkable for the regularity of their growth, and the outline of their peristomes.

Loc. and Horizon.—Harper's Hill, near West Maitland; Lower Marine Series, Permo-Carboniferous. Collected by Mr. J. Waterhouse, M.A.

Platyceras (*Orthonychia*) *ungula*, sp. nov.

Pl. I, Fig. 4.

Sp. Char.—Shell short, conical, hardly curved, obtusely acuminate, scarcely compressed laterally; height quite one-third less than the longest diameter of the mouth, but equal to the transverse measurement of the latter; apex obtuse, sub-central, not overhanging the posterior margin; anterior outline slightly curved; sides more convex than in either of the preceding species; posterior slope slightly convex, not flattened; mouth oval, in one plane, antero-posterior diameter somewhat greater than the transverse; peristome entire; surface with a few irregular concentric ridges, and intermediate finer lines, crossed by microscopically fine striæ.

Obs.—This is a very different form to either *P. cornu-capella* or *P. altum*, much shorter vertically, conical instead of cornute, and with an oval instead of an elliptical mouth. It is also distinct from Dana's *P. tenellum*, and both of the European species described by De Koninck.

There is a curious resemblance in *P. ungula* to many of the straight conical species figured by Barrois from the Devonian rocks of Erbray, France,[†] and rocks of similar age in North America, illustrated by Hall, rather than to ordinary Carboniferous forms.

Loc. and Horizon.—Harper's Hill, near West Maitland; Lower Marine Series, Permo-Carboniferous. Collected by Mr. J. Waterhouse, M.A.

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[*] Foss. Pal. Nouv.-Galles du Sud, Pt. 3, 1877, t. 23, f. 5.

[†] Faune Calc. d' Erbray, 1889, t. 12 and 13.

2.—*Genus* EUOMPHALUS, *J. Sowerby*, 1814.[*]

(Min. Con., I, p. 97.)

Euomphalus cera,[†] sp. nov.

Pl. I, Figs. 5 and 6.

Sp. Char.—Shell depressed, discoidal, wafer-like, of four or five whorls, the inner ones on the upper side of the shell sunk completely below the edge of the body whorl, and their surfaces sloping inwards; section of whorls oval; suture rather channelled; an obtuse keel on the edge of each whorl; back of the body whorl rounded, or very slightly angulated.

Obs.—The mouth of this shell is unfortunately not preserved, and there does not appear to be any sculpture. The present species, even amongst so depressed a group of shells as those composing *Euomphalus*, is remarkable for the degree of compression attained by it, and does not seem to have any very definite allies. No true *Euomphalus* has so far been figured from the Carboniferous or Permo-Carboniferous of New South Wales, but more than one species is now known to have existed. A so-called species was long ago described by M'Coy as *E. minimus*[‡], but without a re-examination it is impossible to say what the shell included under this name may be. The shell figured by De Koninck[§] as *E. catillus*, Martin, a European species, is a very questionable determination, and is probably referable to some other genus. *Euomphali*, of the Group of *E. pentangulatus*, Sby., exist in the Queensland Gympie Series.

Loc. and Horizon.—Seven miles north-east of Paterson on the Dungog-Paterson Road. Mirari Limestone, Carboniferous. Collected by Mr. J. Waterhouse, M.A.

3.—*Genus* MOURLONIA, *De Koninck*, 1883.

(Faune Calc. Carb. Belgique, 1883, Pt. 4, p. 75.)

Mourlonia? Waterhousei, sp. nov.

Pl. I, Figs. 7 and 8.

Sp. Char.—Shell depressed turrited, deeply umbilicate; whorls four (as far as preserved); upper whorls nearly straight-walled, flat and tabulate above, sharply keeled at the peripheries; body whorl generally rounded above and below, bearing three spiral keels, one peripheral in position, a second supra-peripheral, and a third similar, but rather more widely separated from the second than the first and second are from one another; surface, except the space between the first and second keels, which is concave and plain, transversed by spiral raised lines, with traces of indistinct obtuse, or flattened varices, especially on the body whorl.

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[*] Restricted, De Koninck, 1881, Faune Calc. Carb. Belgique, 1881, Pt. 2, p. 136.

[†] *Cera* a wafer.

[‡] Ann. Mag. Nat. Hist., 1847, XX, p. 305, t. 17, f. 4.

[§] Foss. Pal. Nouv.-Galles du Sud 1877, Pt. 3, t. 23, f. 19.

Obs.—The mouth and apex are not preserved; but, I think, a small fifth whorl existed. The concave space between the peripheral and second spiral keel has very much the appearance of a band, which I believe existed in this shell, although from the imperfection of the peristome, no trace of the sinus now exists. On these characters very much depends the systematic position of *Mourlonia.*

At first sight it is not dissimilar to the tabulate *Euomphali*, but the existence of a band, presuming my supposition to be correct, will tend to remove the shell to the Pleurotomariidæ. Adopting this view, then it may be safely stated that no other Australian Palæozoic shell approaches the present species nearer than *Mourlonia subcancellata*, Morris, sp.,* also a more or less tabulate form. In the latter, however, the whorls are much rounder, and proportionately larger, there exists a narrow convex peripheral band on the body whorl, and the whole surface carries a cancellated sculpture.

Loc. and Horizon.—A quarter of a mile north-west of the Water-works, West Maitland; Upper Marine Series, Permo-Carboniferous, named in honour of Mr. J. Waterhouse, M.A., who collected the specimens.

IV.—The Intrusive and Metamorphic Rocks of Berthong, Co. Bland, N. S. Wales, with especial reference to the Occurrence of Serpentine after Amphibolite: by J. B. JAQUET, A.R.S.M., F.G.S., Geological Surveyor.

[Plate II.]

BERTHONG ESTATE is distant about nine miles in a northerly direction from Wallendbeen, and twenty miles in a north-easterly direction from Cootamundra. It is owned by Mr. James Gibb.

The formations represented are as follows:—

SEDIMENTARY.

Silurian.

Slates and Quartzites.

Post Tertiary.

Gravels and Clays.

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* Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, t. 18, f. 6.

Intrusive.

Acid.

- Granitite.
- Eurite.

Ultra-basic.

- Amphibolite.
- Serpentine.
- Diallage rock.

The Silurian slates are much cleaved and otherwise altered. Quartz veins run through them, and some of these veins have been found to contain gold, though not in payable quantities. Large masses or beds of magnetite, with an admixture of quartz occur near the Homestead, and the highly ferruginous character of the soil in the Cultivation Paddock is due to weathered iron-ore which has been washed down from the hills above.

Granitite.

The western boundary of that great boss of granite which runs from near Grenfell in the north, through Young and Murrumburrah to Jugiong in the south, and covers altogether about a thousand square miles of country, passes through the Estate.

The description which is given below shows the rock at Berthong to be referable to the basic granites or granitites; and near Young, a town distant twenty miles, it would seem to be of a similar character since the late Mr. C. S. Wilkinson writes of it as containing hornblende.*

The rock has a specific gravity of 2·73. Examined microscopically it is seen to consist of felspar and quartz with abundant plates of dark mica. It generally shows some sign of lamination, and not infrequently has been changed into a perfect gneiss.

Under the microscope the felspars are seen to all belong to the triclinic variety. Some of them are altering into a felted mass consisting of minute mica fibres, and others have been replaced by fibrous mica altogether. These mica aggregates resemble those which I have described and had figured as occurring in a crushed granitite from the Barrier Ranges.†

The primary mica consists chiefly of biotite, though occasional plates of muscovite are present. The dark mica often includes numerous minute rods of rutile which run in three directions and cross one another at 60°.

Even specimens which appear unaltered to the naked eye yield, when the microscope is brought to bear upon them, abundant evidence of the crushing to which they have been subjected. The quartz appears in the form of rounded granules, which, being grouped together, give rise to mosaics; while plates of mica and felspar lamellæ are bent and twisted, and in some instances broken.

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*Ann. Rept. Dept. Mines for 1876 [1877], p. 154.

†Geology of Broken Hill Lode, p. 59.

Eurite.

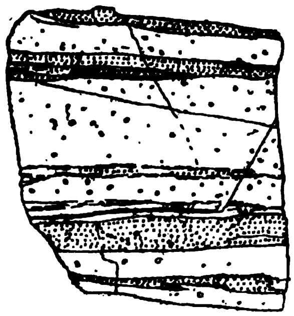
A small boss of this rock is to be found a few chains north of the point where Berthong Creek crosses the southern boundary of Portion 640. (Pl. II.)

It possesses a pale yellow colour and has a specific gravity of 2·61.

Examined microscopically it is seen to be composed of grains of quartz and felspar imbedded in a microcrystalline base. The quartz grains often enclose sheath-like bundles of acicular crystals. The felspars are much decomposed, and many of them exhibit a zonal structure. They sometimes belong to the monoclinic and sometimes to the triclinic variety.

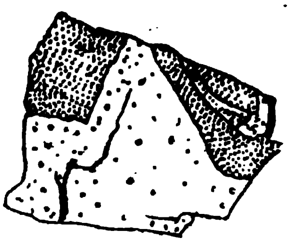
Some specimens which I collected from a point where this rock abuts upon the amphibolites have ragged fragments, and less commonly rounded grains of hornblende scattered in an irregular manner through them. In the same locality bands of a dark green colour occasionally traverse the rock. The microscope shows these bands to differ from the remainder of the mass in containing a much greater number of rounded hornblende grains, which in many instances can be seen flowing round the authigenic felspars. All the circumstances point, I think, to the hornblende grains having had a foreign origin; they were probably derived from the amphibolite at the period of intrusion. Fig. 1 represents a specimen cut from the banded rock. In Fig. 2 the eurite is seen sending a small apophysis into the amphibolite. Under the microscope the latter rock appears to be completely altered. It is composed of broken hornblende grains imbedded in a quartzo-felspathic base. Fragments of hornblende are also to be found in the eurite. The intruder would seem here to be exposed in the act of breaking down, and possibly absorbing, masses of the rock it was intruding.

FIG. 1.



Natural size.

FIG. 2.



⁘ Eurite.

▒ Hornblenoe.

Amphibolite.

This rock, and the serpentine which is associated with it, occur in a shallow basin at the head of Berthong Creek. Dykes of hornblende rock are also to be found in the Silurian slates.

In places the rock is more or less foliated, and might perhaps be described as a hornblende schist, while elsewhere it shows no sign of lamination. Again the components are for the most part of a small size, though from the centrally situated portions hornblende grains half-an-inch or more in length can be obtained.

When examined in thin sections under the microscope the rock is seen to be essentially made up of hornblende grains with a little accessory magnetite and rarely chromite. Some slides show no evidence of dynamo-metamorphic action at all; in others the hornblende has been rolled out and crushed; while in extreme cases the individual grains have lost their identity and are now represented by a more or less confused aggregate of fibres.

Serpentine.

Upon the Geological Map of the Colony serpentine is indicated as being present in the vicinity of Gundagai, Lucknow, Solferino, Oberon, and Bingera, in the Eastern Division. Mention is made of these rocks in various official reports, but no one, so far as I am aware, has given a detailed description of their petrographical character or the relations which exist between them and accompanying formations.

Professor T. W. E. David, when referring to the Bingera serpentine in his report upon a deposit of cinnabar in that locality says that "it results from the alteration of an ultra-basic rock of a decidedly intrusive character."[*] Professor J. W. Judd in a paper recently read before the Mineralogical Society describes two interesting rocks, which occur as dykes in this serpentine.[†] One of them is composed of green garnet and the other of picotite.

In the Collection of the Geological Survey I found specimens of the Bingera rock. It has a mottled green and yellowish-white colour. Dark glistening grains exhibiting a fibrous structure are present in considerable numbers. It polishes well, and forms an ornamental stone of some beauty. The microscope shows it to be composed of serpentine with grains of bastite and picotite (slides 128a and 128b)[‡] A very complete "maschen-structur" is to be seen, so this serpentine has probably been derived from a rock rich in olivine. Mr. P. T. Hammond after making an examination of the Gundagai serpentine in the field, writes of it as having been derived from the "decomposition *in situ* of a basic eruptive rock which has been intruded along the bedding planes of the slates." [§]My Colleague, Mr. G. W. Card, Curator and Mineralogist, has recorded the occurrence of an olivine rock from near Gundagai, which may have been the precursor of the serpentine.[‖]

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[*] Ann. Rept. Dept. Mines and Agric. for 1891, [1890]. p, 235.

[†] Min. Mag., XI, No. 50, p. 63.

[‡] The numbers are those in the Geological Survey Collection.

[§] Records Geol. Survey N. S. Wales, III, Pt. 1, p. 20.

[‖] *Antea*, p. 11.

One occurrence of serpentine has been recorded from near Broken Hill, in the Western District of the Colony. This rock has already been described by the Writer.[*] It contains numerous more or less serpentinised hornblende grains; and a chemical analysis showed the rock to differ from a normal serpentine in containing a considerable quantity of alumina and lime. It would seem to belong to those rarer serpentines after hornblende, and hence has a close affinity to the rock about to be described.

The Berthong serpentine is closely associated with the amphibolite. This circumstance, and the fact that no other possible parent rock is to be found in the vicinity, suggests that the former rock has been derived by a metasomatic process from the latter; and a microscopic examination would seem to confirm this view.

Unfortunately the serpentine is much hidden by a shallow alluvial deposit, which renders the relation which it bears to other rocks somewhat difficult of elucidation in the field. The best sections obtainable are along the course of Berthong Creek. There alternate outcrops of serpentine and amphibolite can be seen, but in no place did I see a line of junction exposed.

The rock in the rough has a dark gray or greenish-gray colour. Polished specimens show a dark gray ground with patches of olive-green and occasional faint tints of red. The appearance of the rock is probably too dark and sombre to cause it to be sought after for decorative purposes. Thin layers of marmolite with a bluish-white colour and pearly lustre are found upon some of the joint planes.

Over considerable areas the rock has been much weathered; sometimes to such an extent that it can hardly be recognised. The weathered portions are impregnated with ferric oxide. In places they include pockets and anastomosing veins of chalcedony.

The serpentine is for the most part homogeneous, and exhibits no sign of mechanical deformation. A schistose structure is, however, occasionally present. In the immediate vicinity of the diallage rock described hereafter foliated serpentine, accompanied by bands of talc-schist, occurs.

Deposits of chromite[†] of a payable character have been discovered in the bed of Berthong Creek. A thin vein of asbestos has also been found in the serpentine. I have already reported upon the occurrence of these economic minerals.[‡]

Under the microscope, by transmitted light, the serpentine presents for the most part a pellucid, homogeneous appearance. It is generally faintly stained with ferric oxide. Chromite and magnetite are invariably present.

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[*] Geology of Broken Hill Lode, p. 57.

[†] The chromite is associated with both serpentine and unaltered amphibolite. Slide 692 is composed of chromite and grains of pale-green hornblende.

[‡] Ann. Rept. Dept. Mines and Agric. for 1895, *in litt.*

These ores are generally found in a broken network which follows original hornblende cleavage planes (Slide 680) or other lines of parting in the rock.

Between crossed nicols the clear mass is resolved into a number of short polarising fibres with isotropic material between. No mesh structure can be observed; nor would the rock seem to resemble in any way a serpentine after olivine. On the other hand the lattice structure, so characteristic of hornblende-serpentine, can be seen; and upon rotating the stage, the boundaries of original hornblende grains can be distinguished by the simultaneous extinction of the material within them.

In one of the slides (No. 680) grains of but little-altered hornblende, with cross-sections showing a well-defined cleavage, occur in a matrix of serpentine.

Analyses of the serpentine and the adjacent amphibolite from which it has been derived have been made by Mr. J. C. H. Mingaye, F.C.S., Analyst to the Mines Department, and are as follows:—

	Serpentine.	Amphibolite.
Moisture at 100° C	2·87	·26
Combined water	10·11	·79
SiO_2	40·80	49·30
Al_2O_3	2·54	10·42
Fe_2O_3	6·20	2·20
FeO	·48	3·83
MnO	trace.	absent.
Cr_2O_3	·29	trace.
CoO and NiO	·25	trace.
CaO	absent.	11·82
MgO	32·82	19·36
Na_2O	·27	1·14
K_2O	absent.	·50
	99·63	99·62
Spec. grav.	2·52	3·00

The analysis shows that the altered rock is a perfect serpentine, and that the parent hornblende was, comparatively speaking, rich in alumina.

Mr. G. F. Becker states—"That Breithaupt is said to have been the first to detect the pseudomorphosis of serpentine after hornblende."* Wiegand, working upon the rocks at Rauenthal in the Vosges in 1875, investigated and described a serpentine after an aluminous hornblende.† He found, upon analysis, that this rock contained a considerable quantity of residual alumina; and he afterwards proved, by treating it with hydrochloric acid and analysing both the soluble and insoluble portions, that it consisted of serpentine with grains of chlorite in which the alumina was present.

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* Becker, Geology of the Quicksilver Deposits of the Pacific Slope. U.S. Geol. Survey, Mon. XIII., p. 118.

† Tschermak, Min. u Petrogr. Mittheil., Vienna, 1875, p. 183 (quoted by Teall, British Petrography, p. 110.

Prof. T. G. Bonney has contributed an article to the *Geological Magazine*, in which he discredits many of the conclusions arrived at by Herr Wiegand.[*] After examining microscopic slides of the Rauenthal rock, he states that while admitting that it contains hornblende which has been transformed into a "serpentinous mineral," yet he is of opinion that the great bulk of the rock represents altered olivine. He opines, in fact, that the parent rock was a hornblende-peridotite, rather than an amphibolite. If Prof. Bonney be correct in his assumption we should expect to find some olivine in the adjacent hornblende rocks, but Herr Wiegand does not report this mineral as being present.

If we admit that under favourable conditions hornblende will undergo a serpentinous alteration—and there would seem to be overwhelming evidence in favour of such an hypothesis—then I fail to see any difficulty in conceiving an extreme case where the change has been a complete one. No one, I think, could view sections of the Berthong rock between crossed nicols without admitting that it had been derived from a rock essentially composed of hornblende; and this rock has the composition of a normal serpentine. In other words, we have conclusive evidence that hornblende has been in this instance completely transformed into serpentine. We can, in the present state of our knowledge, only conjecture as to the circumstances which premit of such a change taking place, involving as it does the removal of alumina and silica in solution. We cannot exactly simulate in the laboratory the physical conditions which may obtain at a great depth beneath the earth's surface; nor is it permitted to us, nor our race, to live long enough to record the effect of insignificant chemical affinities acting over vast periods of time. However, we know that both silica and alumina[†] are dissolved in some spring-waters, and we have reason to believe from their mode of occurrence that many alums have originally been deposited from solution.

Diallage Rock.

Near the "Lick-hole," at the spot indicated upon the accompanying map, there is a small outcrop of this rock, which is bounded upon one side by serpentine, and upon the other by amphibolite. The exact area which it covers cannot be determined on account of the boundaries being hidden by alluvium.

As seen in the field it consists of a number of glistening brown grains which stand out from a dark-gray base. The specific gravity averages 3·04.

Under the microscope, by transmitted light, the diallage grains are seen in some instances to possess a brown, and in others a gray colour. They frequently have ragged ends from which fibres project and wander into the ground-mass, where they gradually lose their identity. The characteristic lamination parallel to the orthopinacoid is exceedingly well developed. The base consists of fragments of diallage, which can frequently be seen becoming detached from the larger grains, more or less serpentinised bundles of fibres, and various alteration products. It would seem to be entirely composed of material brought into existence as the result of decomposition, and the rock at one time probably consisted solely of interlocking diallage grains.

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[*] Geol. Mag., 1887, IV, (3), p. 65.

[†] Mr. J. C. H. Mingaye reports having discovered 47 grains of $Al_2 O_3$ per gallon in a sample of mine-water from Peak Hill, analysed in the Laboratory of the Dept. of Mines. (Ann. Rept. Dept. Mines and Agric. for 1895 [1896], *in litt.*)

Just as the serpentine has been derived from amphibole, so may the amphibole have been previously derived from pyroxene. This small boss of diallage rock may, in fact, be the sole survivor of a large mass of pyroxenic rock which was parent to all the Berthong amphibolites.

Prof. Bonney has described a somewhat similar diallage rock, which is associated with serpentines from the coast of Ayrshire in Scotland*. In a subsequent paper, however, he mentions it as containing a little olivine†.

Conclusion.—There would seem to have been three distinct periods of intrusion at Berthong; firstly we have the intrusion of the Silurian slates by granitite; secondly, the intrusion of both the slates and granitite by an ultra-basic rock; and lastly, the intrusion of the ultra-basic rocks by eurite.

The various rocks, after consolidation, would seem to have undergone great alterations. Granitic rocks have been crushed and rolled out into gneisses; amphibolites under the same influences have been changed into hornblende schists; while chemical agencies, which may or may not have accompanied the earth movements, have effected the complete serpentinisation of large masses of hornblende rock.

It is somewhat curious to notice the discrimination shown by the transforming agencies. Thus one will frequently find a hornblende rock with a perfect foliation, and yet the same rock but a few chains away will show no evidence of schistosity. Similar alternations of granite and gneiss can be observed, but the change is not generally so abrupt. Again, masses of amphibolite occur completely enclosed by serpentine.

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* Quart. Journ. Geol. Soc., 1878, XXXIV, p. 778.

† Geol. Mag., 1887, IV (3), p. 65.

V.—Notes on the Ashford Coal-field, County of Arrawatta: by E. F. PITTMAN, A.R.S.M., Government Geologist.

[Plates III and IV.]

DURING a recent trip to the North I stayed for two days at Fraser's Creek Station, and, through the courtesy of Mr. John Swan, was able to make an examination of the Ashford Coal-seam, and to trace and map the Coal Measures for some distance north and south of Coal Gully, where the coal was first discovered.

The Ashford Coal-seam was first examined and reported upon by Professor David (at that time a Geological Surveyor in the Department of Mines) in 1885,* and the same gentleman also briefly alluded to it (after a second visit to the locality) in his Presidential Address to the Linnean Society in 1893.†

The Ashford Coal-field possesses unusual interest, both from its mode of occurrence and from the fact that it is the most northerly extension of the coal-bearing rocks of Permo-Carboniferous age in New South Wales. It consists of a long narrow belt of conglomerates, shales, ironstone, and sandstone with a seam of coal about twenty-seven feet thick divided by a number of bands. Below the main body of the coal is a bed about two feet thick of brownish clay shales, with very numerous impressions of *Gangamopteris*, while in the sandstones above the coal *Glossopteris* also occurs. The palæontological evidence, therefore, taken in conjunction with the great thickness of the coal, leaves little doubt that these Coal Measures are identical with the Greta Group, the lowest as well as the most interesting of the Permo-Carboniferous Series.

The greatest width of the Ashford Coal Measures (measured horizontally across the strike) is only about three hundred and seventy yards, which, allowing for the dip, would give an actual thickness of the beds of only about two hundred and thirteen yards.

The measures have a general strike of about N. 30° E., and their dip is W. 30° N., at an angle of about 40°. They are bounded on the east by beds of dark bluish-gray and yellowish indurated claystones, which have a general strike of N. 20°—30° W., and dip E. 20°—30° N., at angles varying from 40° to 70°. These claystones were not observed to be fossiliferous; but they were traced by me without any break in their continuity from Southern Queensland, where they are regarded by Mr. Jack (Government Geologist of Queensland) as Gympie Beds, and they are apparently identical in their lithological characters and mode of occurrence with the Lower Carboniferous beds of the Vegetable Creek District referred by Professor David to the Gympie horizon.* It will be observed from the details given above, and from the sketch section accompanying this paper, that there is a very strongly marked unconformability between the Carboniferous or Gympie claystones and the Permo-Carboniferous Coal Measures which dip off them. This unconformability was previously alluded to by Professor David,† and is of special interest as bearing upon the view taken by the Geological Survey of New South Wales in referring these marine claystones to the Carboniferous Period. It appears difficult to reconcile such a marked stratigraphical unconformability, strengthened as it is by the palæontological break observable in other localities, with the classification of the Queensland Geological Survey, which includes the claystones (Gympie Beds) with the Permo-Carboniferous Series.

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* Ann. Rept. Dept. Mines for 1885 [1886], p. 139.
† Procs. Linn. Soc. N.S. Wales, 1893, VIII (2), p. 586

The Ashford Coal Measures are bounded on the west (along the greater part of their length) by a belt of intrusive granite, and this feature is of special interest, because the preponderance of the evidence appears to me to indicate that the intrusion occurred after the deposition of the Permo-Carboniferous Coal Measures.

The coal bears evidence of having been considerably altered. The lowest portion of the seam has a highly lustrous anthracitic appearance, and shows numerous polished or slickensided surfaces, which cause it to break up into small lenticular fragments several inches in length. Moreover, the upper portions of the seam present a dull semi-coked appearance, and, as will be seen by the analyses which are appended, have evidently lost a considerable proportion of their volatile hydrocarbons. The seam is inclined at a considerable angle, the dip being towards the granite in the only section in which it is visible.

It is not easy to account satisfactorily for the present position of the Coal Measures in relation to the granite. It appears probable, however, that they were originally deposited (in a denuded hollow) on the upturned edges of the Carboniferous (Gympie) claystones, and that there subsequently occurred an intrusion of granite, which caused foldings in the claystones and elevated some of the western portion of the Coal Measures (since removed by denudation), causing the western side of the remaining Coal Measures to sink, and thus assume the present inclination. It is, of course, possible that the intrusion of the granite may have occurred prior to the deposition of the Coal Measures, and that the inclined position of the latter may be due to a fault along the eastern side of the granite. This supposition, however, would not account for the alteration in the character of the coal, and I am, therefore, inclined to think that the former hypothesis is the more correct one.

The coal-seam is exposed in Coal Gully about two miles south of Fraser's Creek Homestead, but owing to the amount of weathering it has undergone it is impossible to get an accurate section showing the number of bands and the thickness of clean coal between them. The following rough section of the measures was, however, taken by me, the measurements representing the true thickness of the beds :—

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* Proc. Linn. Soc., N. S. Wales, 1893, VIII (2), p. 587.
† *Loc. cit.*

	ft.	in.
Roof—hard, fine-grained, grayish-white flaggy sandstone	2	7
Coal, with bands	27	0
Reddish-brown shales	0	8
Coal, with bands	1	3
Brownish clay-shales with numerous impressions of *Gangamopteris*	1	3
Carbonaceous shales, with thin seams of dirty coal and obscure plant impressions	15	6
Blue shales, with a band of nodular ironstone three feet from the base	18	2
Ferruginous conglomerate—the pebbles being formed of Carboniferous (Gympie) claystone	3	10
	70	3

Floor—Carboniferous (Gympie) claystones, lying unconformably.

It was impossible to obtain a section of the Measures further west than the roof of the coal-seam, because they were there covered by from six to eight feet thick of a horizontally-bedded gritty sandstone, which is probably of Tertiary age.

A shaft forty-one feet deep has recently been sunk in the coal-seam close by the spot where it outcrops in Coal Gully, and from this shaft about forty tons of coal have been extracted and used, chiefly in blacksmiths' forges about the district. With the aid of a borrowed rope I was enabled to descend the shaft, and obtained the following section of the coal at the bottom. Unfortunately there were no facilities for examining the coal at a greater height than six feet from the shaft bottom, and I am unable, therefore, to give any description of the quality of the coal nearer the roof of the seam, nor to record the thickness of clean coal between the bands :—

Section at bottom of shaft.	ft.	in.
(A) Hard coal, slightly coked	2	6
Shale band	0	2½
Hard coal, slightly coked	0	6
(B) Rather friable coal	0	6
Band	0	1
Splint coal	0	9
Shaly coal	1	6
(C) Splint coal	1	5
Coal and shales	0	9
(D) Slickensided anthracitic coal	1	9
Brownish clay shales—Floor of seam.	9	11½

Samples of the coal from A, B, C, and D were taken, and proximate analyses of these were subsequently made in the Geological Survey Laboratory by Mr. J. C. H. Mingaye, F.C.S., with the following results :—

Sample of slightly coked coal. (A)		
Specific gravity	1·328	
Hygroscopic moisture	·65	
Volatile hydrocarbons	22·15	
Fixed carbon	71·65	Coke, 77·20 %
Ash	5·55	
	100·00	

Sulphur in coal, ·480 %. Ash, light-gray in colour, granular. Coke, fairly well swollen, fine and lustrous. One pound of this coal will convert 13·53 lb. of water into steam.

Sample of rather friable coal. (B)

Specific gravity	1·342	
Hygroscopic moisture	·55	
Volatile hydrocarbons	24·65	
Fixed carbon	67·80	Coke, 74·80 %
Ash	7·00	
	100·00	

Sulphur in coal, ·357 %. Ash, light-gray in colour, granular. Coke, well swollen, fine and lustrous. One pound of this coal will convert 14·08 lb. of water into steam.

Sample of splint coal. (C)

Specific gravity	1·349	
Hygroscopic moisture	·75	
Volatile hydrocarbons	23·25	
Fixed carbon	68·90	Coke, 76 %
Ash	7·10	
	100·00	

Sulphur in coal, ·357 %. Ash, light-gray in colour, granular. Coke, well swollen, hard and lustrous. One pound of this coal will convert 13·86 lb. of water into steam.

Sample of slickensided anthracitic coal. (D)

Specific gravity	1·374	
Hygroscopic moisture	·90	
Volatile hydrocarbons	21·55	
Fixed carbon	67·50	Coke, 77·55 %
Ash	10·05	
	100·00	

Sulphur in coal, ·453 %. Ash, light-gray in colour, granular. Coke, fairly well swollen, hard and lustrous. One pound of this coal will convert 13·86 lb. of water into steam.

It will be seen by the above analyses that the coal from the Ashford Seam is likely to prove an excellent fuel for steam or smelting purposes, and that in regard to calorific value, and percentage of ash, it compares favourably with many of the best coals of the Colony.

About one mile south of Coal Gully the Coal Measures were again seen in the bed of a small creek, and the following section was measured from west to east. The dip of the measures here is west at 35°. The coal-seam itself is not seen at the surface in this section:—

	feet.
Rather coarse bluish-gray conglomerates	206
Gray sandstone with *Glossopteris*	224
Concretionary ironstone	6
Strata covered by sand in creek-bed	51
Bluish-gray conglomerate with band (two feet) of concretionary ironstone	3½
Strata covered by sand in creek-bed	69
Coarse basal conglomerate	70½
Gympie claystones, dipping E. 2° N., at an angle of about 60°.	

About a mile and a half still further south some highly-indurated conglomerates and sandstones are visible in the bed of a small watercourse, and these appear to be the continuation of the Coal Measures, though the cause of the metamorphism is not apparent.

The country along the course of the Severn River is so covered by Pleistocene and recent deposits that it is a matter of much difficulty to define the limits of the Permo-Carboniferous rocks, which outcrop only in the beds of creeks or water-courses.

To the north of Coal Gully the first evidence of the coal occurs at a point close to Fraser's Creek Homestead. Here, after heavy floods, large masses of coal, weighing sometimes as much as a hundredweight, are found in the river, and there is every reason to believe, therefore, that the seam outcrops here in the bed of the Severn River. Unfortunately there is a long and deep waterhole covering the spot, so that it is impossible to fix it accurately.

A traverse of Myall Creek, which trends about due west, and enters the Severn River about a mile to the north of the spot just referred to, shows that Carboniferous (Gympie) claystones outcrop in every bend, for a distance of over two miles up the creek.

The geological formation underlying the reaches of the creek, between the bends, is hidden by deposits of sand, and it is of course possible that the narrow belt of Permo-Carboniferous Coal Measures may cross the creek under one of these reaches. It is hardly probable, however, that this could happen without some evidence of the presence of the Coal Measures being visible in such a deeply-cut dry creek, and I am inclined to think that the Coal Measures do not cross the creek, though there is evidence of their recurring further northward, near Bonshaw. The granite crosses the Severn River just at the junction of Myall Creek, and inclusions of Carboniferous (Gympie) claystones are here visible in the granite, pointing to the probability of the intervening Coal Measures having been entirely carried away by the intrusion at this point.

The road going in a westerly direction from Bonshaw towards Mendoc passes for about five miles over Carboniferous (Gympie) claystones. For a distance of about a mile very sandy soil is then met with, and a small outcrop of grayish gritty sandstone occurs on the eastern side of the sand belt; the road comes on to granite immediately after passing the sandy belt. I passed over this road some days before inspecting the Ashford Coal-seam, and while noting the occurrence of the sand belt and single outcrop of sandstone I had no idea that it was upon the strike of the Ashford seam. I think now, however, that there are strong reasons for believing that this sandy belt marks the extension northwards of the Permo-Carboniferous Coal Measures, especially as I was subsequently informed by Mr. Nicholls (who originally discovered the Ashford Seam) that there is an outcrop of coal showing in a small creek ten miles north of Fraser's Creek Homestead, and about one mile west of the Bonshaw Road.

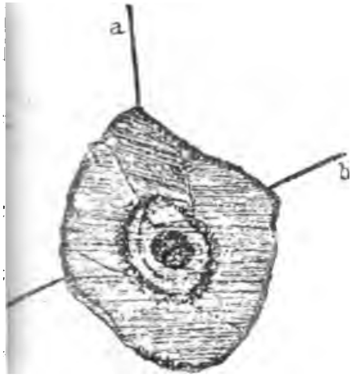
In conclusion, it may be remarked that the Ashford Coal-field, though limited in width, is of considerable importance on account of the excellent quality and thickness of the coal, as well as its distance from the nearest workable seam, and there is no reason to doubt that, with the advent of railways through this district, the deposit will become a valuable one.

VI.—Ottrelite-Phyllite from near Wattle Flat: by GEORGE W. CARD, A.R.S.M., F.G.S., Curator and Mineralogist.

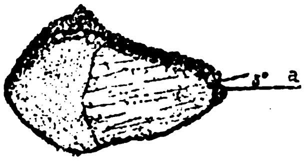
THIS note is based upon a brief examination of a small specimen described as coming from Bullock Flat, four and a half miles south-east from Wattle Flat, Sofala.

The rock is a blackish-green glossy phyllite. In every direction it shows the glistening faces of numerous detached lozenge-shaped plate-like crystals, having an average diameter of about a millimetre. The faces have a resinous to metallic lustre, are strongly curved, and are somewhat scaly. The plates cannot be satisfactorily detached from the rock, in which they lie without any definite orientation. They are affected by weathering to a much greater extent than the rock itself, becoming brown and earthy. The hardness of the mineral approximates to that of apatite; while the rock itself lies between two and three of Moh's Scale. The streak is practically colourless.

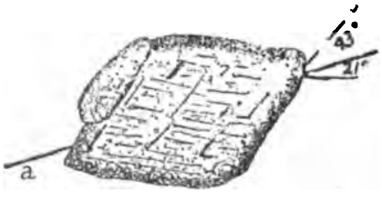
A microscopical examination of a very thin section [752] reveals this mineral in lozenge-shaped transparent grey crystals embedded in a fine-textured matrix of a pale buff colour. The crystals have sometimes an outline somewhat suggestive of a hexagon with the angles rounded off. The transparency of the crystals is interfered with by the presence of a multitude of dark specks and particles quite like those occurring in the base of the rock. The outline is very irregular, but is in most cases tolerably well defined. A dark border, of a width sometimes equal to one-sixth the length of a side, is always present. A concentric zoning, parallel to the outline, and consisting of dark bands merging into the mass of the crystal, is very common. The zoning is generally more marked towards the centre. In one instance there were indications of a diagonally-placed cross, as in chiastolite.



1.
Irregularly lozenge-shaped crystal; showing zoning and composite structure as seen between crossed nicols.
a....position of extinction in the small segment.
b.... do in the main crystal.



2.
Compound crystal, the individual on the right showing irregular cleavage.
a....position of extinction in the right-hand individual—inclined about 5° to the cleavage.



3.
Lozenge-shaped crystal showing dark margin and two directions of cleavage, to which one position of extention is inclined about 43° and 21° respectively; the angle of intersection being rather more than 60°, In the upper left-hand corner is a smaller individual (?).

Well-developed cleavage lines are present, but they have a tendency to pass into irregular cracks. Fig. 3 shows a crystal in which two sets of cracks intersect at an angle of rather less than 120°, while Fig. 2 shows only one set. Zoning and cleavage would not appear to occur together.

But little can be done with a quarter-inch objective towards the differentiation of the base of the rock; but the general similarity between it and the base of the crystals, as noticed before, is confirmed.

The slide being very thin, the crystals are quite colourless; but their potential pleochroism is abundantly indicated by the strong change from light to dark when the slide is rotated above the polariser.

The index of refraction is moderately high.

Between crossed nicols the ground-mass is seen to be crystalline throughout, polarising in shades of yellow, and having a streaky appearance. It can probably be regarded as consisting essentially of *sericite.* No colouration effects are afforded by the crystals beyond the change from light to dark already noted. The double refraction is therefore low. No satisfactory determination of optical sign could be made. Occasional indications of what may perhaps be twin-structure are brought out between crossed nicols. Fig. 1 illustrates the best instance of this. On rotating the stage the lozenge-shaped crystal is found to be compound in structure; a small segment, shown in the upper part of the figure by different shading, extinguishing in a different position to the remainder. One direction of extinction for the large and the small portions is indicated approximately by the lines *a* and *b* respectively. These directions are nearly at right angles to one another, so that there is, perhaps, but slight difference in the orientation of the two portions. It will be noticed that the zonal bands traverse the small segment, and that there seems to be a sort of overlapping of the different portions within the zone. In a sense the crystals shown in Figs. 2 and 3, may be regarded as compound, the cleavage cracks in each case occurring in one portion only. It would seem probable, however, that this structure is not due to true twinning, but to an actual mechanical change of position in the case of Fig. 1; while Figs. 2 and 3 may, perhaps, represent associated crystals. To sum up: the principal characters of the mineral—mode of occurrence and appearance, pleochroism, and cleavage—all seem to point towards a mineral of the *chloritoid* group, such as *ottrelite.* On the other hand the characteristic axis colours of that mineral have not been obtained, and the hardness is distinctly below that of typical ottrelite.

The deficiency in hardness may, perhaps, indicate that a large porportion of the substance of the crystal consists of included rock—a conclusion to which the similarity in microscopic appearance also seems to point—while the thinness of the section might account for the absence of colour.

It is evident that we have here a clayslate that has been converted into a phyllite by the development of minute crystalline structure, and in which crystals of what would appear to be a chloritoid mineral have been produced probably subsequent to the development of crystallisation. Adopting the nomenclature of Zirkel in the second edition of the "Lehrbuch der Petrographie," the mineral would appear to be *ottrelite* and the rock an *ottrelite-(sericite-) phyllite.*

It is much to be hoped that someone interested in the phenomena of contact metamorphism may trace this interesting rock to its home, and make an exhaustive examination of its characters.

VII.—The Occurrence of Platinum in New South Wales: by J. B. JAQUET, A.R.S.M., F.G.S., Geological Surveyor.

GRAINS of platinum have not infrequently been met with in some of the auriferous drifts in the Colony. Prof. Liversidge mentions a nugget weighing two hundred and sixty-eight grains, as having been obtained from the bed of Wiseman's Creek, near Oberon.[*]

It is also found associated with gold and gemstones in the sea beaches between the Richmond and Clarence Rivers, and occasionally small parcels have been saved by miners working in these localities for gold.[†]

From a scientific point of view, perhaps the most interesting platiniferous deposits are those at Little Darling Creek, and Mulga Springs, near Broken Hill. Here the metal is found in ironstone, ferruginous claystones and decomposed gneiss. Samples assayed in the Department of Mines Laboratory by Mr. J. C. H. Mingaye yielded from traces up to 1 oz. 9 dwts. of platinum per ton.[‡] Some of the samples contained small quantities of gold and silver, and the ironstone was generally more or less impregnated with carbonates of copper. No platinum could be seen in the ore, experiments made to determine the condition in which it is present have resulted in failure, while attempts at concentration have only been partially successful.[§] During 1892 the Writer made an examination of the deposits in the field. The figure below which illustrates their general mode of occurrence is reproduced from his report.[||]

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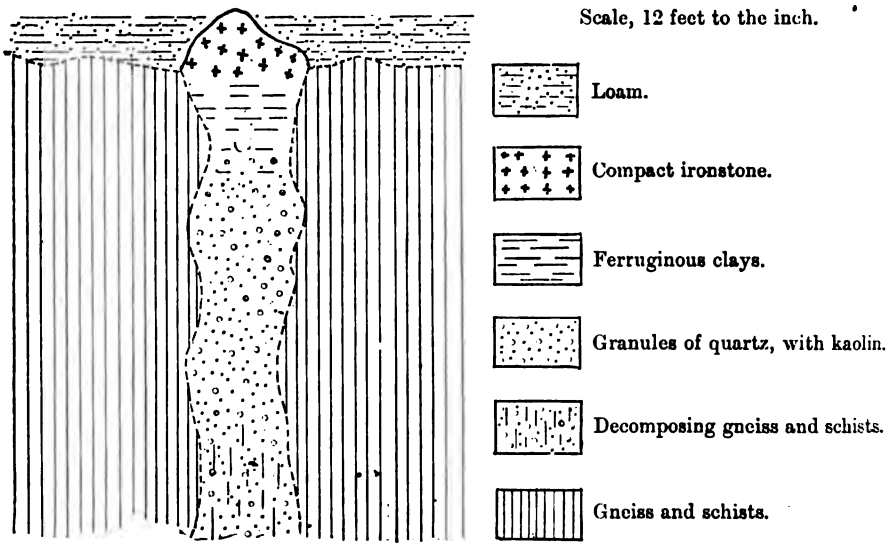
[*] Minerals of New South Wales, p. 52.

[†] Records Geol. Survey N. S. Wales, IV, Pt. 1, p. 25; Ann. Rept Dept. Mines for 1878 [1879], p. 43; Procs. R. Soc. N. S. Wales, XXVI, p. 368; Ann. Rept. Dept. Mines and Agric. N. S. Wales for 1895 [1896], *in litt.*

[‡] Ann. Rept. Dept. Mines for 1889 [1890], p. 249; Procs. R. Soc. N.S. Wales, XXVI, p. 371.

[§] Ann. Rept. Dept. Mines and Agric. for 1891 [1892], p. 276.

[||] Ann. Rept. Dept. Mines and Agric. for 1892 [1893], p. 142.


Scale, 12 feet to the inch.
Loam.
Compact ironstone.
Ferruginous clays.
Granules of quartz, with kaolin.
Decomposing gneiss and schists.
Gneiss and schists.

Ideal Section of Platinum Deposit near Broken Hill.

Until the recent discovery of alluvial deposits in the vicinity of the newly surveyed townships of Fifield and Platina, there had been no production of platinum, upon a commercial scale, in New South Wales. These townships are situated about twenty-six miles north-east of Condobolin, and fifty-four miles north-west of Parkes, and are distant from one another one and a half miles.

During the last two decades it would appear that the country around Fifield has been intermittently prospected for alluvial gold, and a little platinum must from time to time have been obtained, though there is no record of this metal being discovered prior to 1887.

In this year Mr. J. F. Connolly, who received aid from the Government to prospect the district, reported having discovered alluvial platinum, and presented a sample to the Geological Museum. Nothing appears to have been done in the way of further developing the field until 1893, when Messrs. Fifield, Rand, and Party discovered rich alluvial gold near the site of the present township of Fifield.* Upon news of the discovery becoming known a rush set in to the district, and the lead which is now being worked was found soon afterwards.

The sedimentary formations represented are slates of Silurian (?) age, and fossiliferous sandstones and limestones of either Devonian or Siluro-Devonian age.

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* Ann. Rept. Dept. for Mines and Agric. 1893 [1894], p. 63.

Mr. W. S. Dun, Assistant Palæontologist, has identified the following forms as occurring in specimens of the latter beds which I collected, and those which were given to me by Mr. C. J. Metcalfe, of Fifield :—

Limestone—
- Rhynchonella, sp. indet.
- „ allied to R. cuboides, *Sby.*
- Spirifera.
- Athyris.
- Cyclonema.
- Orthoceras.

Sandstones—
- Monticuliporoid corals, 2 genera.
- Rhynchonella, 2 species.
- Tentaculites.
- Pleurodictyum.

The Silurian slates are intruded by diorite. A thin section of this rock, which I examined under the microscope, consisted essentially of grains of hornblende and triclinic felspar with some accessory sphene and quartz.

Near Melrose Plains Homestead an auriferous reef has been discovered in the diorite, and a little exploratory work carried out upon it.

The "lead" or ancient water-course, which yields the gold and platinum-bearing drift, runs in a north and south direction for a little over a mile. It is from sixty to one hundred and fifty feet wide. The drift containing the precious metal is overlain by from sixty to seventy feet of loam with occasional bands of barren quartz drift. The platinum and gold occur in small, well water-worn grains, and are practically confined to the crevices in the bed-rock and the dirt within a few inches of the bottom. Occasional nuggets have been obtained which have weighed from a few grains up to 8 dwts.

The washdirt is first of all puddled in machines worked by horses. During this process the soft layer of bedrock which is broken down with the drift is pulverised and any metal which may be attached to it set free. The clean gravel is afterwards washed in ordinary sluice-boxes and the gold and platinum obtained. The gold is extracted by amalgamation with mercury and crude platinum left behind. The latter realises at the present time, upon the fields, twenty-four shillings per ounce. It contains about seventy-five per cent. of platinum, the balance being chiefly platinoid metals and iron.

An analysis by Mr. J. C. H. Mingaye, F.C.S., Analyst and Assayer to the Mines Department, gave as follows :—

Platinum	75·90	per cent.
Iridium	1·30	„
Rhodium	1·30	„
Palladium	traces.	
Osmiridium	9·30	„
Iron	10·15	„
Copper	·41	„
Gold	nil.	
Lead	traces.	
Siliceous matter	1·22	„
	99·48	

Value of Wash-dirt.

No. of Claim.	Loads washed.	Yield.						Ratio of platinum to gold in round numbers.	Value per load.		
		Platinum.			Gold.						
		oz.	dwt.	gr.	oz.	dwt.	gr.		£	s.	d.
4½ South	65	17	3	0	5	6	0	3 to 1	0	12	2
4½ ,,	16	5	9	12	1	11	22	3 ,, 1	0	15	8½
10 ,,	34	8	5	12	2	4	0	4 ,, 1	0	10	8
12 ,,	14	3	9	0	0	12	12	6 ,, 1	0	9	0
3 ,,	13	6	0	0	1	10	7	4 ,, 1	0	19	4
10 ,,	24	10	3	0	2	0	9	5 ,, 1	0	16	0
6 ,,	35	11	0	0	4	8	0	3 ,, 1	1	0	0
12 ,,	30	12	11	0	3	13	12	3 ,, 1	0	19	4
2 ,,	16	6	11	12	2	4	6	3 ,, 1	1	0	3
14½ ,,	2	1	2	6	0	6	6	4 ,, 1	1	4	6
9 ,,	2	0	16	6	0	5	2	3 ,, 1	0	19	3
3½ ,,	2	0	15	16	0	5	0	3 ,, 1	0	18	9
12½ ,,	2	1	12	9	0	9	21	3 ,, 1	1	17	10½
14½ ,,	6	3	8	12	0	13	12	5 ,, 1	1	2	1½
13 ,,	4	1	8	3	0	7	9	4 ,, 1	0	15	4
14 ,,	4	2	13	6	0	11	12	5 ,, 1	1	6	3

Mr. C. J. Metcalfe has kindly furnished me with the above returns obtained on treating parcels of dirt from various claims upon the lead.

It will be seen that the quantity of platinum per load varies from 5 to 12 dwts., and the quantity of gold from 1 to 3 dwts.; while the total value of the precious metals per load varies from 9s. to 37s.

Amongst the returns will be noticed several trial lots of two loads each from large dumps of dirt which have yet to be treated. These lots were in most instances, probably, picked samples, and have given a yield in excess of that which will be obtained from the dumps as a whole.

A somewhat curious specimen, which was given to me by a miner upon the field and is now in the Geological Survey Museum, (No. 6665)* deserves some notice here. It consists of a water-worn grain of platinum imbedded in a moderately hard, compact, white, amorphous substance. A qualitative analysis showed the matrix to consist essentially of a mixture of magnesium and calcium carbonates with a little insoluble aluminous material. The specimen was described to me as occurring *in situ* as a portion of a narrow lode in the bed-rock; but the waterworn character of the platinum grain would seem to preclude such an origin. In a shaft upon the field which had penetrated decomposing diorite to a depth of forty feet, I saw veins composed of a white material identical with the matrix of the specimen. It would seem to me that the metallic grain originally fell into a crack in the surface of the diorite and that the magnesian limestone was afterwards deposited around it.

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* Registered number in Geological Survey Collection.

Only three well-authenticated instances of platinum occurring *in situ* would seem to be on record; at Sudbury, in Canada, it occurs chemically combined with arsenic*; at Broken Hill, as I have previously mentioned, distributed through ironstone and decomposed gneiss; and in Brazil in veins (?) associated with gold.† In Russia, where alluvial platinum deposits of enormous extent are to be found, the source of the metal has never been found and is still a matter for conjecture; so a considerable amount of scientific interest is attached to the genesis of platinum in all newly-discovered deposits.

In the vicinity of Fifield and Platina at an elevation of at least a hundred feet above the lead which is now being exploited outliers from a series of horizontally bedded conglomerates, or cemented drifts and shales, occur. The conglomerates are composed of rounded or subangular quartz-pebbles tightly cemented together by an infiltration of ferric oxide. The shales are highly ferruginous and much indurated.

In the absence of fossils I am unable to speak definitely as to the geological age of these beds; however, having regard to their general character and the amount of denudation that has taken place since their deposition, I am inclined to think that they are of Tertiary age, or even older.

Upon the top of Jack's Look-out, a low hill which is distant about two miles from Fifield in a south-easterly direction, a good section of the beds is to be seen. Here they have been found to contain water-worn grains of gold and platinum, and some prospecting work has been carried out upon them. As is generally the case with widely distributed auriferous drifts the precious metals occurred in patches and not in defined "runs." This fact and the great expense of treating the hard cement discouraged the miners, and all work has now been abandoned in this locality.

I obtained from the Fifield-Platina lead boulders of cement, which were indistinguishable lithologically from portions of the beds upon Jack's Look-out; and I am of opinion that the precious metals in the lead were originally contained in those portions of the conglomerate and shale beds which have been denuded away; I am suggesting, in fact, that the older beds with their scattered patches of platinum and gold have been disintegrated and ground-sluiced by nature, and that the deposits now being worked represent the resultant concentrates. If we admit this hypothesis then the ultimate source of the metals is still an open question. It is possible that the components of the Tertiary (?) beds may have been derived from a source far removed from Fifield.

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* Am. Jour. Eng. Sci., 1889, XXXIX., p. 67. (*Fide* Mineral Industry, 1893, I, p. 376)

† Geol. and Phys. Geog. of Brazil, Prof. Hartt. (*Fide* Mineral Industry 1893, I, p. 376.)

It was suggested to me that the platinum might have been derived from a reef or reefs in the vicinity of the field. A consideration of the general mode of occurrence of platinum would perhaps cause one to discredit such a theory, and the ascertained facts seem to me to disprove it altogether. The dividing line of the Bogan and the Lachlan River watersheds passes through Fifield, and the platinum deposits have been followed up one side of the ridge and down the other. So one or more of the supposititious reefs should be located upon the highest ground; yet, notwithstanding all the sinking and driving that has been carried out, no reefs had been found. Moreover, the grains of metal appear to be uniformly waterworn.

Dry seasons have prevailed since the discovery of the field, and its development has been much retarded in consequence. The washing of dirt has sometimes been completely suspended for many months at a time on account of the shortage of water. At the present time 7,000 loads of washdirt are dumped around the various shafts awaiting treatment.

About 1,200 oz. of crude platinum have already been sent away from this field, and, including the deposits in the immediate vicinity of Fifield and outside the Fifield-Platina Lead proper, the gold won has totalled about 1,800 oz.

A few of the parties have already worked out all the "pay-dirt" from their claims, while others have a year or eighteen months' work in sight.

A consideration of the circumstances connected with the origin of the platinum and the fact that it has been found in small quantities over a wide area of country has made me of opinion that other platiniferous leads are to be found in places under the flats in the district. Prospecting for such leads, however, would be a very tedious operation, since the flats are for the most part of great extent, and there is nothing upon the surface to indicate the path of the gutters below.

Small quantities of drift yielding a payable quantity of platinum associated with gold and tin (cassiterite) have been mined about ten miles north-east of Fifield, near the village of Burra Burra.

Though no very rich ground has been found at Fifield, yet employment has been found for from 150 to 200 men at a time when a field for their labour was sorely needed. Moreover, with the opening up of the field a new industry has been created, and an addition made to the long and varied list of mineral products exported from New South Wales.

VIII.—The Occurrence of Copper at the Dottswood Mine, Queensland: by GEORGE W. CARD, A.R.S.M., F.G.S., Curator and Mineralogist.

[Plate V.]

THIS property is situated south-east from Keelbottom Creek, fifty miles from Townsville. Having lately had an opportunity of examining a few rock specimens and cores, the Writer considers that the occurrence of copper there is sufficiently interesting to justify a reference to it in these Records. The specimens, together with particulars of their position in the bores, were obtained from Mr. W. S. Head. A plan and section taken from the Prospectus of the Company will be found on Plate V. By reference to this plate it will be seen that the copper deposit has been reached by shafts and bores for a distance of four hundred feet from the outcrop; the dip being very low at first, and then increasing to about 45°. Overlying the bed in which the rich copper ore occurs there is, in every case, a reddish pseudo-amygdaloidal rock [755], which is also stated to constitute the surface rock of the district. A little native copper is said to have been found in this.

In every instance after this has been passed through it is succeeded by a compact black rock containing copper [634, 756], and it is at the base of this bed that the ore-body has, up to the present, been invariably met with. The total thickness is said to be about five feet, while the ore-body varies up to eighteen inches. The ore would seem to consist principally of native copper with siliceous and calcareous gangue; but oxidised ores are also said to occur. Wherever the ore-body has been passed through, it is succeeded by a grey spotted rock [759], and in this the occurrence of copper has not yet been recorded. A bore has been driven fifty feet into this grey rock. Some twenty years ago this property was inspected by Messrs. Norman Taylor, W. S. Phillips, and Thos. Symons. The former gentleman describes (in a report to the Company) the hanging-wall as consisting of "altered and very hard cherty and epidotic rock," and the "lode" as resting on a "dyke of amygdaloidal trap." He also refers to having observed "slickensides" in some specimens of ore. Mr. Symons refers to another lode about half a mile from the other workings. At a depth of fifteen feet "the lode opened out to about two feet; this lode showed a good sample of stone, bearing oxide and copper, and runs nearly east and west, with an underlay of about three feet in six." An examination of the specimens revealed the following features:—

[755.] A reddish pseudo-amygdaloidal rock. A multitude of lath-shaped felspar microlites are thickly set with calcite and ferrite in a dusty base. A marked fluidal structure is noticeable. The amygdaloidal structure results from the replacement of the original rock substance rather than from an infilling of vesicular cavities. This rock is described as overlying the cupriferous bed, and is said to sometimes contain copper.

[634, 756.] From different depths in different bores. One specimen itself contains native copper, while the other is described as coming from just above the ore-body. They are identical in character, consisting of lath-shaped felspar microlites closely crowded in a fluidal manner with chlorite, viridite, and ferrite. The alteration products (chlorite, &c.) appear to result from the replacement of felspars and interstitial matter. The rock is traversed by secondary veins, and contains secondary quartz in considerable quantity.

[757, 758.] These were detached (by the Writer) from a lump of the ore-body rich in native copper. [758] is identical with [634] and [756], except that it is veined, and in part replaced by quartz, calcite, and iron-oxide. [757] is a mass of quartz and calcite.

[759.] A grey pseudo-amygdaloidal rock underlying the ore-body, and not known to be cupriferous. Tabular felspars—some porphyritic—are closely crowded, with chlorite, viridite, and ferrite.

Thus only two varieties are present. [755–8, 654] represent a mass of rock characterised by lath-shaped microlites of felspar arranged fluidally; this mass comprises the ore-body. [759] is characterised by tabular felspar—porphyritic crystals and microlites.

No augite or olivine has been recognised in any of the rocks. There is a close resemblance between them and the "*diabase-porphyrite*" described by Iddings from the Lake Superior Copper Mines. It may be convenient to refer to them as *melaphyres* in the field, but in all probability on further study they will be found to be altered *andesites*, the *porphyrites* of some English petrologists. Messrs. Etheridge and Jack refer incidentally * to cupriferous old lava beds, consisting of porphyrite, at Keelbottom Creek, and to these the rocks now being examined doubtless belong.

Two important deductions can be drawn from these results:—

1. If the sample of ore examined be really characteristic, then there is no true lode present, and it is somewhat surprising that slickensides should have been observed. The specimen was an integral portion of the porphyrite traversed by veins of, and to a certain extent replaced by, calcite, chlorite, ferrite, &c., and containing native copper.

---

* Geology of Queensland, Brisbane, 1892, p. 133.

2. The uniform character of the overlying rock, and its structure, the flatness of the surface, and the low angle of dip, all point to a lava flow rather than a dyke. It seems most probable that the underlying rock is of the same nature.

There would thus appear to be a series of bedded flows of porphyrite, the copper occurring more or less scattered through the upper bed, and concentrated with a siliceous and calcareous gangue as an ore-body in the upper bed just at its contact with the next.

There is an analogy between the occurrence of copper here and at Lake Superior, where the metal is found replacing, and filling up interstices in, interbedded conglomerates and various basic volcanic rocks, some of which closely resemble the Dottswood porphyrites. These have proved cupriferous for more than five thousand feet, but not continuously. At Walli, a few miles north of Woodstock, in New South Wales, there is a similar occurrence.

In the event of copper-mining being pursued in this district, it would be very desirable to prove the presence or absence of copper in succeeding strata by deep bores.

PLATE I.

Platyceras (Orthonychia) altum, *Dana?*

Fig. 1. A complete specimen, lateral view, showing the general curvature of the shell, over-hanging apex, concentric laminæ, and radiating striæ. Harper's Hill.

Fig. 2. A second specimen rather more curved, in which the radiating striæ are less distinct. Harper's Hill.

Platyceras (Orthonychia) cornu-capella, *Eth. fil.*

Fig. 3. Lateral view of the shell, minus the apex, with gradate concentric ridges, and remains of faint radiating striæ. Harper's Hill.

Platyceras (Orthonychia) ungula, *Eth. fil.*

Fig. 4. Lateral view of the short conical shell, with irregular concentric ridges. Harper's Hill.

Euomphalus cera, *Eth. fil.*

Fig. 5. Upper or apical view exhibiting the depressed whorls, and obtuse keel around the edge of the body whorl. Dungog-Paterson Road.

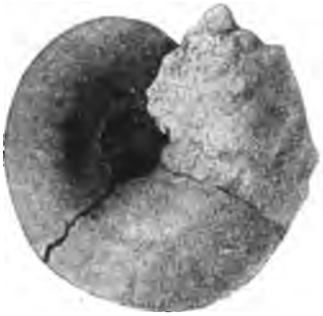
Fig. 6. Side view of the same specimen, showing the discoidal wafer-like outline.

Mourlonia? Waterhousei, *Eth. fil.*

Fig. 7. Side view, with the depressed turreted whorls; the upper straight-walled, the body whorl with its three carinæ. West Maitland.

Fig. 8. Basal view of the same specimen, with the deep umbilicus.

42-1-5



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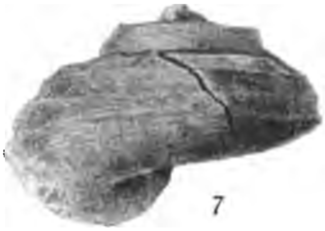

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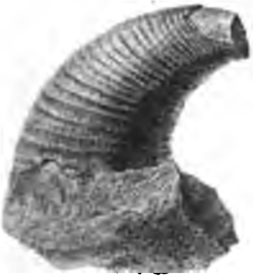

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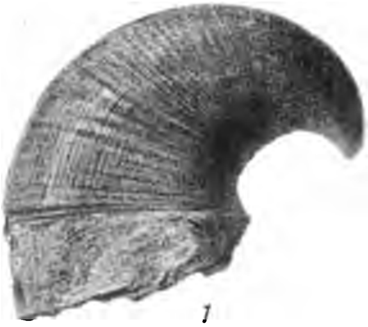

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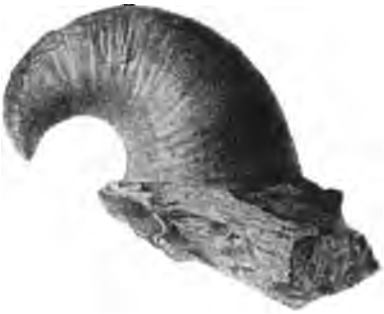

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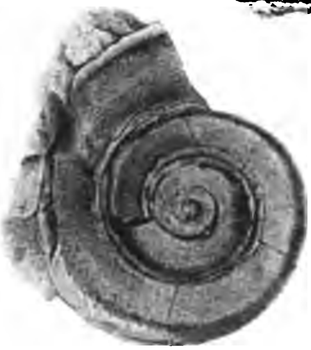

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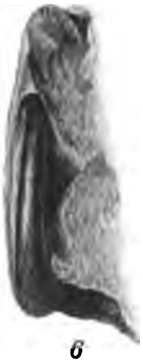


6

P. T. Hammond, del.

Heliotype.

PLATE II.

Geological sketch map of the Berthong District, Co. Bland—showing the mode of occurrence of the Intrusive and Metamorphic rocks.

Scale—100 chains to 1 inch.

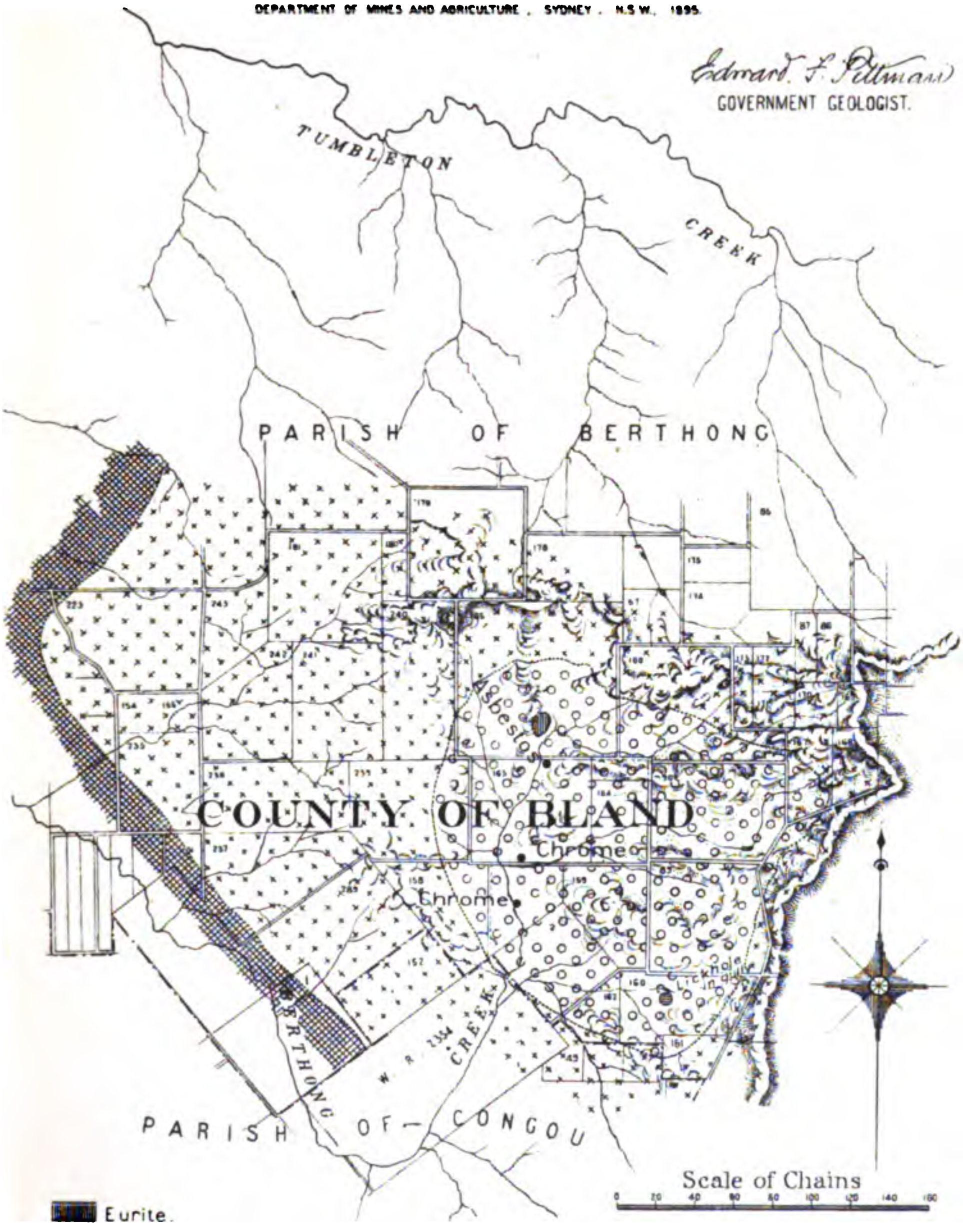
GEOLOGICAL SKETCH MAP

To accompany report by J.B. JAQUET, A.R.S.M., F.G.S., Geological Surveyor, on the

BERTHONG ESTATE NEAR WALLENDBEEN

DEPARTMENT OF MINES AND AGRICULTURE, SYDNEY, N.S.W. 1895.

Edward F. Pittman
GOVERNMENT GEOLOGIST.



▨ Eurite.
☒ Granitite and gneiss.
▩ Altered slates and quartzites, with intrusions of amphibolite.
○ Serpentine, amphibolite, and hornblende schists.
■ Diallage rock.

(11a176-99-6)

PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE.
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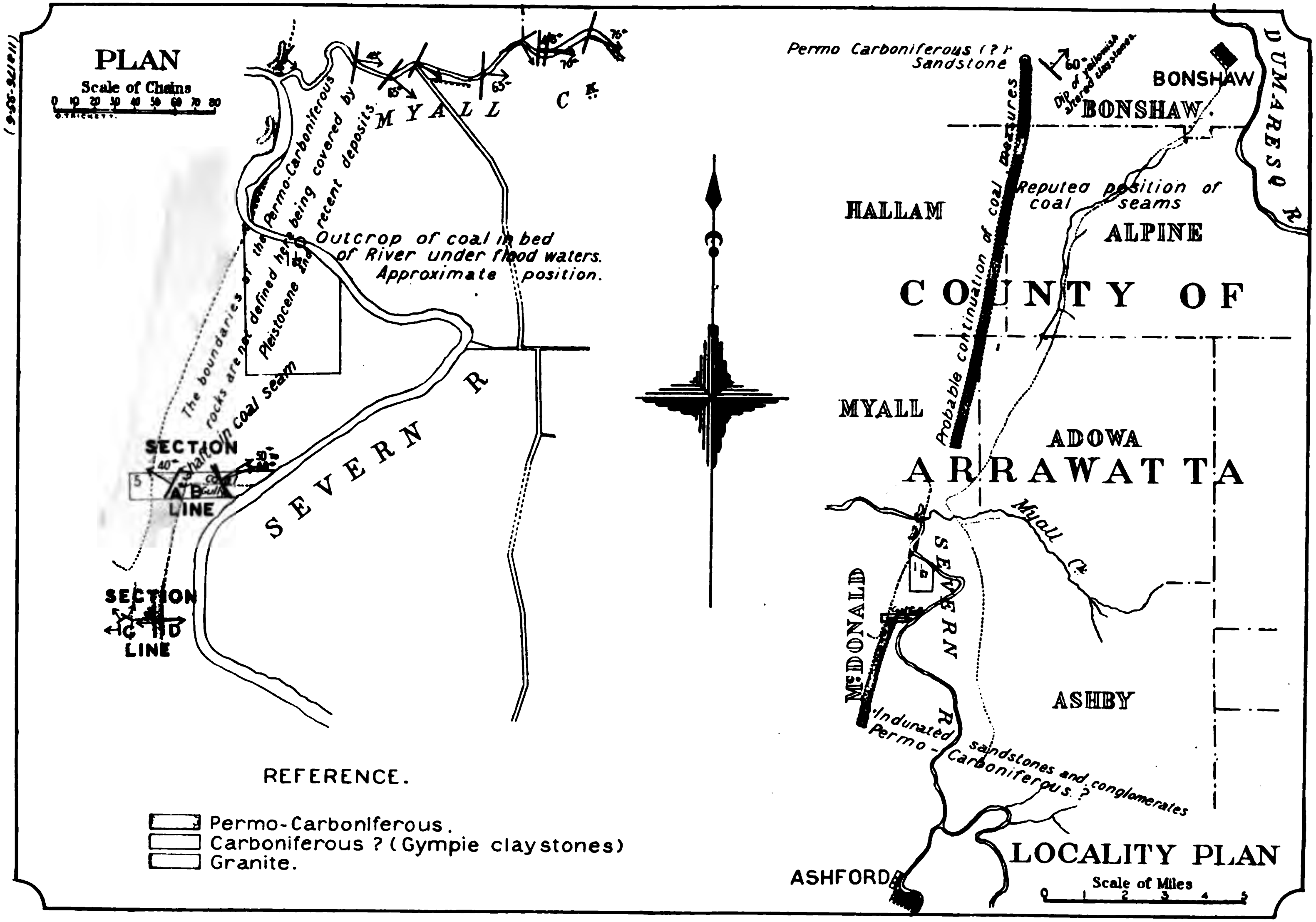
PLATE III.

Geological sketch map of the Ashford Coal Measures.

Scale—80 chains to 1 inch.

Plate III.


PLAN
Scale of Chains
0 10 20 30 40 50 60 70 80
MYALL C K.
65°
63°
70°
76°
The boundaries of the Permo-Carboniferous rocks are not defined here being covered by Pleistocene and recent deposits.
Outcrop of coal in bed of River under flood waters. Approximate position.
Shaft in coal seam
SECTION A B LINE
40°
50°
5
coal
SECTION C D LINE
SEVERN R
Permo Carboniferous (?) Sandstone
Dip of yellowish sheared claystones
60°
BONSHAW
BONSHAW
DUMARESQ R
Reputed position of coal seams
Probable continuation of coal measures
HALLAM
ALPINE
COUNTY OF ARRAWATTA
MYALL
ADOWA
Myall Ck
SEVERN R
McDONALD
ASHBY
Indurated sandstones and conglomerates Permo-Carboniferous ?
ASHFORD
LOCALITY PLAN
Scale of Miles
0 1 2 3 4 5

REFERENCE.

- ▭ Permo-Carboniferous.
- ▭ Carboniferous ? (Gympie claystones)
- ▭ Granite.

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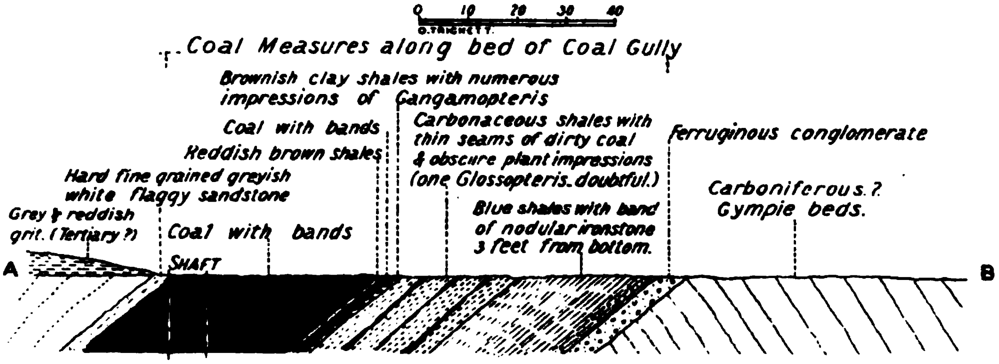
PLATE IV.

Sections to accompany the Geological sketch map of the Ashford Coal Measures.

Scales on Plate.

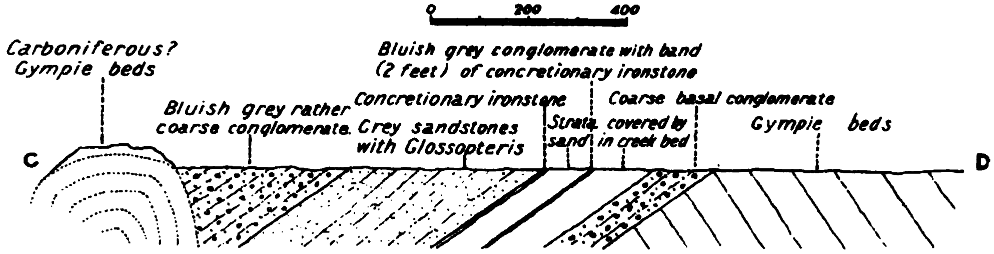
SECTION ON LINE A B

Scale of Feet.

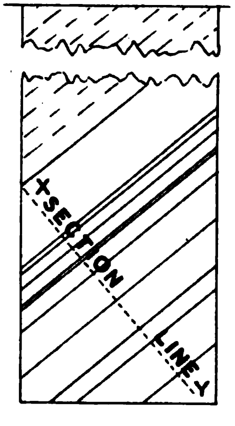

0 10 20 30 40
..Coal Measures along bed of Coal Gully
Brownish clay shales with numerous impressions of Gangamopteris
Coal with bands
Reddish brown shales
Carbonaceous shales with thin seams of dirty coal & obscure plant impressions (one Glossopteris, doubtful.)
Ferruginous conglomerate
Hard fine grained greyish white flaggy sandstone
Carboniferous.? Gympie beds.
Grey & reddish grit. (Tertiary ?)
Coal with bands
Blue shales with band of nodular ironstone 3 feet from bottom.
A
SHAFT
B

SECTION ON LINE C D

Scale of Feet


0 200 400
Carboniferous? Gympie beds
Bluish grey conglomerate with band (2 feet) of concretionary ironstone
Bluish grey rather coarse conglomerate.
Concretionary ironstone
Grey sandstones with Glossopteris
Strata covered by sand in creek bed
Coarse basal conglomerate
Gympie beds
C
D

Shaft
About 41 feet deep.



SECTION ON LINE X Y

Scale of Feet

0 2 4 6 8

	Ft	In	
X	2	6	.. Hard coal slightly coked.
	0	2½	.. Shale band.
	0	6	.. Hard coal slightly coked.
	0	6	.. Rather friable coal.
	0	1	.. Band.
	0	9	.. Splint coal.
	1	6	.. Shaly coal.
	1	5	.. Splint coal.
	0	9	.. Coal and shale.
	1	9	.. Slickensided anthracitic coal.
Y			..... Brownish clay shales.

(11a 176-95-6.)

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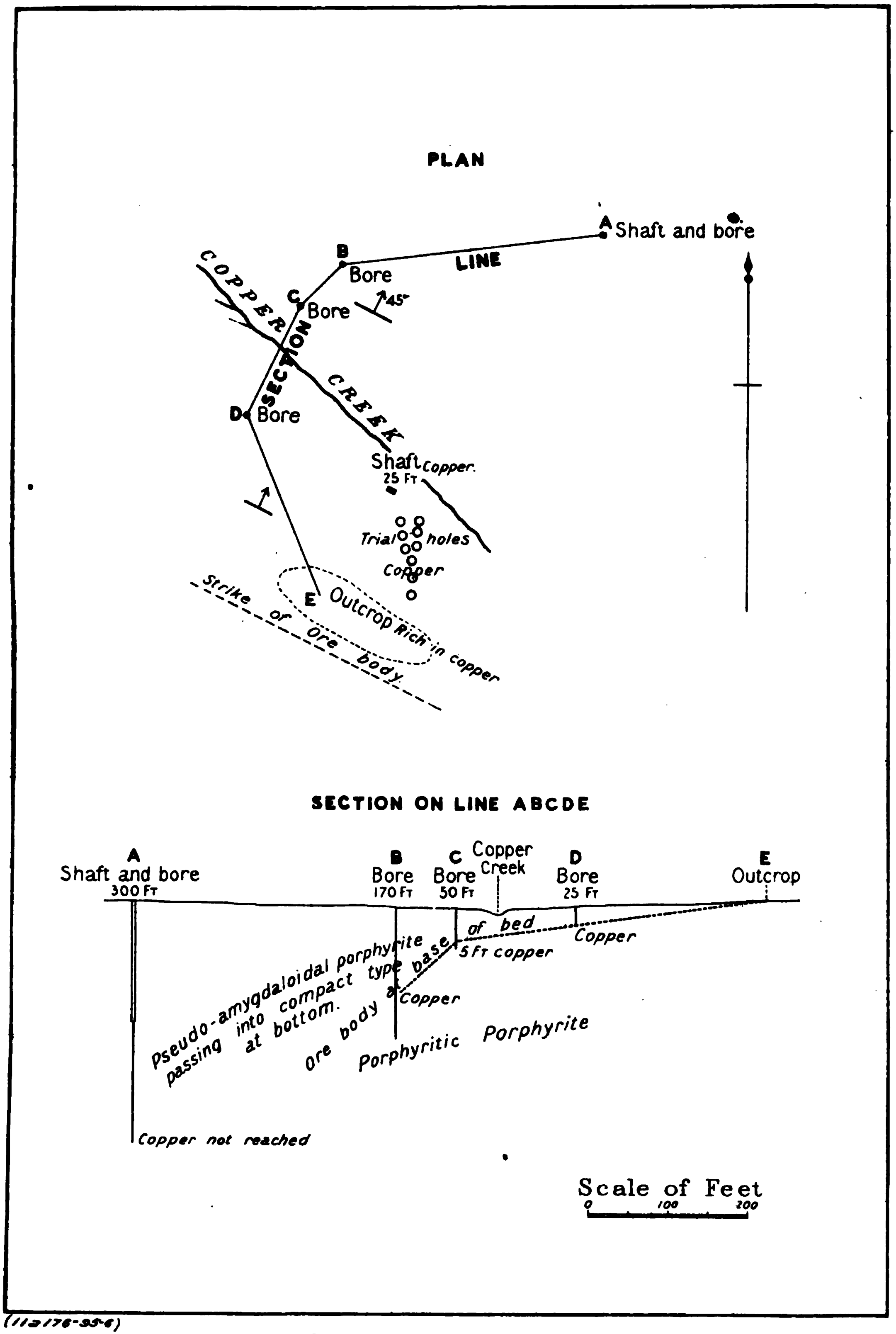
PLATE V.

Sketch Plan and section of the Dottswood Copper Mine, Queensland.

Scale—200 feet to 1 inch.



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GEOLOGICAL MAPS AND PUBLICATIONS ISSUED BY THE DEPARTMENT OF MIN AND AGRICULTURE, SYDNEY.

(1.) MAPS.

Map showing Mineral Areas of New South Wales. Scale, 16 miles to 1 inch.
Do do do Scale, 50 miles to 1 inch.
Geological Sketch Map of New South Wales, compiled from the Maps of the late Rev. W. B. Clarke, M.A., F.R.S., C. S. Wilkinson, L.S., F.G.S., Government Geological Surveyor-in-charge. Scale, 8 miles to 1 inch.
Do do do do Scale, 22 miles to 1 inch.
Do do do prepared under the direction of E. F. Pittman, &c., &c., Governm Geologist. Scale, 16 miles to 1 inch.
Geological Map of the Districts of Hartley, Bowenfells, Wallerawang, and Rydal, by C. S. Wilkinson, L.S., F.G.S.
Geological Map of Hill End and Tambaroora, by E. F. Pittman, Geological Surveyor.
Geological Map of the Vegetable Creek Tin-mining District, by T. W. E. David, B.A., F.G.S., Geological Surveyor. Sca 58 chains to 1 inch.
Index Map of the Vegetable Creek Tin-fields, by T. W. E. David, B.A., F.G.S. Scale, 90 chains to 1 inch.
Geological Map of the Forest Reefs District, by H. Y. L. Brown, Geological Surveyor.
Map of the Silver-mining Country, Barrier Ranges, by C. S. Wilkinson, L.S., F.G.S.
Vertical Sections of New South Wales Upper Coal Measures, by John Mackenzie, F.G.S., Examiner of Coal-fields.
Diagrams showing the Thickness, Character, and Portion mined out of Coal-seams in the Coal Measures of New Wales, by John Mackenzie, F.G.S., Examiner of Coal-fields.
Plans showing the Outcrop, Thickness, and Dip of the Coal-seams in the Northern, Southern, and Western Coal-m Districts of New South Wales, by John Mackenzie, F.G.S., Examiner of Coal-fields.
Geological Sketch Map showing boundary of the Cretaceo-Tertiary Formation in the County of Cowper, by W Anderson, Geological Surveyor, 1889.
Geological Sketch Map of Tertiary Deep Lead, Tumberumba, by William Anderson, 1890.
Sketch Map showing Geological Features between Peak Hill; Geological Map showing the principal Stanniferous Lo the Tingha and Elsmore Districts, by the late C. S. Wilkinson, F.G.S., F.L.S., and T. W. E. David, B.A., F.G 1895, and Tomingley, by William Anderson, 1890.

(2.) PUBLICATIONS.

The Mining Act of 1881, with Regulations.
Annual Reports from 1875 to 1893 inclusive.
Mines and Mineral Statistics, 1875. [Out of print.]
Mineral Products of New South Wales, 1882, containing:—
1. Mineral Products of New South Wales, by Harrie Wood, J.P., Under Secretary for Mines.
2. Notes on the Geology of New South Wales, by C. S. Wilkinson, L.S., F.G.S., Geological Surveyor-in-Charge.
3. Description of the Minerals of New South Wales, by Archibald Liversidge, M.A., F.R.S., F.C.S., F.G.S., Professor of Chemistry and Mineralogy in the University of Sydney.
4. Catalogue of Works, Papers, Reports, and Maps on the Geology, Palæontology, Mineralogy, &c., &c., of the Australian Continent and Tasmania, by Robert Etheridge, Junr., of the British Museum, and Robert Logan Ja F.R.G.S., F.G.S., Government Geologist for Queensland.

Mineral Products of New South Wales, 2nd Edition, 1886, containing:— [Out of print.]
1. Mineral Products of New South Wales, by Harrie Wood, J.P., Under Secretary for Mines.
2. Notes on the Geology of New South Wales, by C. S. Wilkinson, L.S., F.G.S., Geological Surveyor-in-Charg
3. The Collieries and Boghead Mineral Mines of New South Wales, by John Mackenzie, F.G.S., Examiner of Coal-Fiel

Memoirs of the Geological Survey of New South Wales.

Geology.
1. Report on the Vegetable Creek Tin Mining District, by T. W. E. David, B.A., F.G.S., Geological Surveyor.
5. Geology of the Broken Hill Lode and Barrier Ranges Mineral Field, New South Wales, by J. B. Jaquet, A.R.S.M., &c. (4to. Sydney, 1894.)

Palæontology.
1. The Invertebrate Fauna of the Hawkesbury-Wianamatta Series of New South Wales, by Robert Etheridge, Jun Palæontologist to the Geological Survey of New South Wales, and Australian Museum, Sydney. (4to. Sydney, 1888.)
2. Contributions to the Tertiary Flora of Australia, by Dr. Constantin, Baron von Ettingshausen, Prof. of Bo University of Graz, Austria. (4to. Sydney, 1888.)
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5. A Monograph of the Carboniferous and Permo-Carboniferous Invertebrata of New South Wales. Part 1 Cœlenterata: Part 2, Echinodermata, &c.; by R. Etheridge, Junr. (4to. Sydney, 1891-92.)
7. The Mesozoic and Tertiary Insects of New South Wales, by R. Etheridge, Junr., &c., and A. Sidney Olliff, (4to. Sydney, 1890.)
8. Contributions to a Catalogue of Works, Reports, and Papers on the Anthropology, Ethnology, and Geolog History of the Australian Aborigines, Parts I—III; by R. Etheridge, Junr. (4to. Sydney, 1890-95.)
9. The Fossil Fishes of the Talbragar Beds (Jurassic), by A. S. Woodward, &c. (4to. Sydney, 1895.)

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Vols. I—IV (Sydney, 1889-95.)

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OF THE

GEOLOGICAL SURVEY OF NEW SOUTH WALES,

VOL. V, PART II.

1897.

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Vol. V.] January, 1897. [Part 2.

CORRIGENDA.

Vol. V, Part I, p. 35, line 22. For *Mr. J. C. H. Mingaye, F.C.S.*, read *Mr. H. P. White, F.C.S., Assistant.*

A. H. Foord, when describing Carboniferous fossils from West Australia, met with evidence that produced in his mind a contrary opinion, for amongst species recorded by him occurs *Syringothyris exsuperans*, De Kon. sp., apparently determined from fragmentary dental plates, in the first instance, that were found to piece together,† and subsequently portions of the ventral valve displaying characteristic features.

The valves of *Spirifera exsuperans* externally present all the characters of *Syringothyris.* The shell is subpyramidal, transversely elongate, both valves possessing acute and extended cardinal alations or extremities. The ventral or peduncle valve is very long (*i.e.*, from the umbo to the front), with a shallow wide sinus, much produced forwards. The umbo is high, feebly curved, pointed, channelled, and only overhanging the cardinal area at its extreme apex. The cardinal area is high, large, and extends the whole length of the valve, longitudinally striate, and with a large triangular fissure or delthyrium, which is partially closed by an arched deltarium. The exterior is ornamented by a large number of usually simple rounded radiating costæ, except in the sinus, which appears to be destitute of them. The costæ are separated by narrow shallow inter-costal spaces, whilst imbricating laminæ or strong lines of growth probably existed, although they are only now faintly visible in the specimens before me.

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* Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 249.
† Geol. Mag., 1890, VII (3), pp. 149, 153.

The dorsal or brachial valve is much less convex than the ventral, with a depressed rounded fold; its umbo also depressed, and inconspicuous; the fold without costæ, but a median longitudinal groove, the outward evidence of the median septum.

De Koninck's description is at first difficult of comprehension. In the first place he does not describe the ventral valve by name, but speaks of the dorsal as possessing a "lobe médian simple," that can be no other than the fold. He adds "crochet très élevé," "area très grand"; "un petit pseudodeltidium." These characters are those of parts of the ventral valve, not the dorsal. Now, although all the foregoing points are correct in themselves as specific features of the shell, it appears to me that the Author in framing his description has commenced with the characters of the ventral and leaped to those of the dorsal valve, without diffentiating between them. There can be no other reading, for the "lobe médian simple" settles the matter. I refer to this, because it must be exceedingly puzzling to the ordinary reader, and has a strong bearing on what I have to say later on.

De Koninck describes the internal structure of the ventral valve as follows:— Two strong diverging dental plates occupy the interior of the ventral valve, of which the frame-work is perfectly consolidated. Between these plates, which do not extend for more than half the depth of the valve, and immediately below their junction is visible the central adductor, impressioned in the form of a lozenge (rhomboidal), longitudinally grooved, and flanked by two very deep cardinal impressions striated lengthwise. The remainder of the interior of the valve exhibits irregular oblique grooves, probably dependant on the vascular markings.

All of the specimens of this shell that have come under my notice, with the exception of two, are from the Carboniferous rocks of New South Wales, the exceptions being from beds of similar age in West Australia. We may now proceed to a consideration of the specimens figured in Pl. VI.

Fig. 1 is the most complete example in the Mining and Geological Museum from a N. S. Wales locality that has so far been collected. It represents the cardinal area of a ventral or peduncle valve, delthyrium, and slightly incurved and channelled umbo, with a fairly well preserved dorsal valve in apposition. In this example some portion of the testaceous matter is retained on the ventral valve, but not on the dorsal, except here and there as a thin pellicle. The upper third of the delthyrium is infilled with a slight shelly plate, on a level with the general surface of the area, broken at its lower extremity, but this is not represented in the drawing. This is probably the remains of a deltarium. Each edge of the delthyrium is bordered by a rounded raised rim or beading, and on its inner side the delthyrial grooves. The umbo is also seen to be channelled by the sinus quite to its apex, and faint traces of transverse striation are also visible on the area. The very close general resemblance borne by this specimen to other species of *Syringothyris* is apparent.

In the dorsal valve the low broad fold is seen to be devoid of costæ, but exhibits the impression of the septum and the simple costæ on the lateral slopes are visible.

Fig. 2 represents a specimen somewhat similar to Fig. 1, but the whole of the testaceous matter is removed from the area except on one side. This removal enables the position of the dental plates as diverging slits to be seen. Towards the apical portion of the fissure is the cast of what Prof. W. King termed the "arch," or commencement of the dental plates;[*] Dr. Thomas Davidson, the "transverse plate;"[†] and Messrs. Hall and Clarke, the "transverse rostral plate."[‡] The dorsal valve attached to this specimen exhibits characters similar to those of Fig. 1, except that there are faint indications of costæ on the fold.

A crushed specimen devoid of testaceous matter is depicted in Fig. 3, generally similar to Fig. 2, except that, possibly in consequence of the distortion it has undergone, the "arched," or "transverse plate" is much wider. Again the apical portion of the ventral sinus is visible as a groove on the cast of its umbo, the impression of the dorsal septum on the fold, and the costæ on the lateral slopes. The slits left by the decomposition of the dental plates are wide and deep. This figure corresponds remarkably well with one of Messrs. Hall and Clarke's of the cardinal view of an internal cast of *Syringothyris Randelli*, Simpson.

Figs. 5 and 6 are views of one and the same specimen, and as they exhibit similar features to those already described in other specimens need not be further referred to.

The myology of *Spirifera exsuperans* is only known from the imperfect specimen, Fig. 4, the ventral view of an internal cast. The muscular impressions occupy a similar area circumscribed by the dental plates, here represented by slits, as in *Spirifera* and *Syringothyris*, but the drawing does not do justice to the structure as preserved. The small double adductor impressions are faintly visible, separated by the short ventral septum, here a groove, and more apparent towards its forward portion. The cardinal or diductor impressions, one on either side of the adductors, are more plainly visible as oval impressions radiately ridged. A comparison may be made with one of the excellent figures of Messrs. Hall and Clarke, in this instance again to that of *Syringothyris Randelli*, Simpson,[§] and to some extent to one of Prof. King's also.[‖]

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[*] Ann. Mag. Nat. Hist., 1868, II (4), p. 16, t. 2, f. 11.

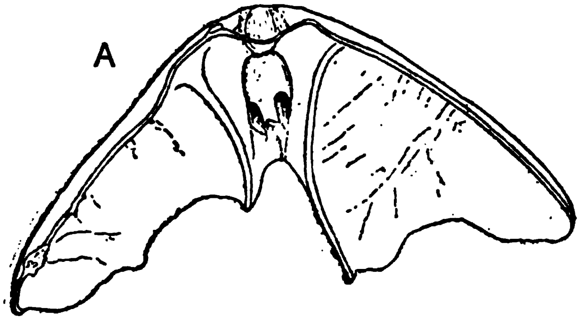
[†] Geol. Mag., 1867, IV, pp. 312, 315, t. 14, f. 7-9.

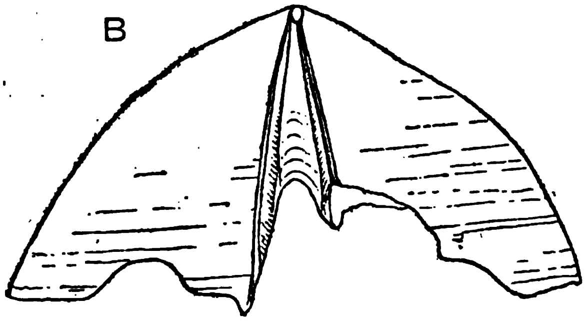
[‡] 13th Ann. Report State Geol. N. York for 1893 (1894), II, t. 30, f. 4.

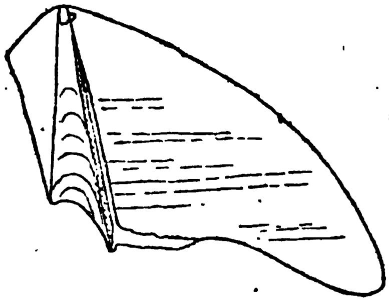
[§] 13th Report *loc. cit.*, t. 30, f. 6.

[‖] Ann. Mag. Nat. Hist., *loc. cit.*, t. 3, f. 31.

The foregoing appears to be all the information that can be gained from the New South Wales specimens of *Spirifera exsuperans*, and we may now turn our attention to two from the Carboniferous rocks of West Australia :—


A


B


C

Both these essentially bear out the structure of those from New South Wales, but also have the advantage of possessing the whole of the testaceous matter, so far as the shells are preserved.

Fig. B. has the same wide, high, and transversely-striated ventral area, and open delthyrium floored by the transverse plate with its excavated lower margin as in the previously described specimens from New South Wales; also the delthyrial grooves and thickened margins are plainly visible. The transverse plate in this specimen is particularly well-developed. It is not to be mistaken for the deltarium, which in perfect examples either arches over the delthyrium, as seen in one of Prof. King's excellent illustrations,[*] and illustrated by Hall and Clarke in *Syringothris Randelli*, Simpson,[†] as well as in the only Australian specimen in which this structure has been observed[‡]; or, is apparently composed of two halves, being thus figured by Davidson in *Syringothyris distans*[§]. The arched deltarium does not necessarily entirely close the delthyrium, but leaves a semi-circular opening within a short distance of the umbo of the dorsal valve, as illustrated by Prof. King[‖], and described by Schuchert in *Syringothyris alta*, Hall[¶]. The present specimen also exhibits on one side the transverse plate, the line of separation between it and the contiguous dental plate as a rather wide groove, extending almost to the excavated lower end.

The second specimen (Fig. C) from West Australia is only one-half the ventral area, being broken off short at one of the dental plates, exposing a lateral view of this structure descending into the valve, the line of separation having taken place along the groove previously described at the side of the transverse plate in Fig. B.

The first figure (Fig. A) represents the interior of Fig. B, and is an instructive one. The dental plates are worn down, although the bases are still visible. A mass of testaceous matter fills the umbonal cavity, rendering it very solid. In the centre of this is a somewhat pyriform depression, occupied by a slight prominence, tailing off below into a narrow projection, leaving on either side an elongated slit. The surface of the lateral internal portions of the area outside the dental plates bear numerous vascular markings.

In a typical *Syringothyris*, from the lateral margins of the transverse plate, on its inner side, shelly processes or plates are given off, and curling towards one another, are partially united in the middle line forming an imperfect tube termed the syrinx, and first observed in these shells by Professor N. H. Winchell. By Messrs. Hall and Clarke this is regarded as the receptacle of the atrophied pedicle.[**] There are numerous good illustrations of this tube, for instance, in *Syringothyris distans*, Sby., by Davidson[††]; in *S. typa*, Winchell, by the same author[‡‡], and Hall and Clarke[*]; in *S. subcuspidata*, Hall, again by Hall and Clarke[†], and also in *S. texta*, Hall, by the same[‡]. It is possible that the downward projection in the pyriform depression of Fig. A, may represent this syrinx either in a still more atrophied, or even undeveloped state.

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[*] Ann. Mag. Nat. Hist., *loc. cit.*, t. 2, f. 1.
[†] 13th Ann. Report State Geol. N. York, *loc. cit.*, t. 30, f. 11.
[‡] Foss. Pal. Nouv.-Galles du Sud, Pt. 3, 1877, t. 15, f. 1.
[§] Geol. Mag., 1867, IV, t. 14, f. 7 and 9.
[‖] Ann. Mag. Nat. Hist., *loc. cit.*, t. 2, f. 1.
[¶] 43rd Ann. Rept. N. York State Mus. for 1889 (1890), p. 237.
[**] 45th Ann. Report N. York State Mus. for 1891 (1892), p. 483
[††] Geol. Mag., 1867, IV, t. 14, f. 6-9.
[‡‡] *Ibid*, f. 4.

The result of my investigation of the structure of *Spirifera exsuperans* seems to show that it agrees with *Syringothyris* in most of its characters, departing from that type only in the more trivial. Even admitting that the projection from the pyriform depression on the underside of the transverse plate is not the remains of a syrinx, this will not wholly invalidate the reference to *Syringothyris*, since Mr. C. Schuchert has described[§] at least one species (*S. Herricki*) in which this tube was not present. In this case both *Spirifera exsuperans* and *Syringothyris Herricki* will be more in accord with certain species of American *Spirifera*, such as *S. plenus*, Hall, which is said to have the shell structure of *Syringothyris*, and a well-developed transverse plate without a syrinx.

The reference of De Koninck's species to *Syringothyris* is still further borne out by the punctate and at the same time peculiarly fibrous structure of the shell. The punctæ (Pl. VI, Fig. 7) are distinctly visible on the lateral slopes of another specimen not otherwise figured. No trace of the perforations is to be seen on any of the ventral areas.

Localities:—Greenhills, nine miles north-east of Paterson, County of Durham, N. S. Wales (*C. Cullen*); Shelly ridge, twenty miles west of Tamworth, County of Parry, N. S. Wales (*C. T. Musson*); Nolan's 640 acres Selection, Parish of St Aubyn, County of Durham, N. S. Wales; Carboniferous.

Gascoyne River, W. Australia (*H. P. Woodward*); Carboniferous. Mr. A. H. Foord also records *Syringothyris exsuperans* from both the Gascoyne and Irwin Rivers in West Australia[‖].

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[*] 13th Ann. Report State Geol. N. York, *loc. cit.*, t. 30, f. 15.

[†] *Ibid*, f. 3.

[‡] *Ibid*, f. 5.

[§] 43rd Ann. Report N. York State Mus., *loc. cit.*, p. 233.

[‖] Geol. Mag., 1890, VII (3), pp. 149, 153.

X.—On the Occurrence and Classification of some New South Wales Meteorites, by GEORGE W. CARD, A.R.S.M., F.G.S., Curator and Mineralogist.

[Plates VII & VIII.]

THERE are in the Mining and Geological Museum, Sydney, the Cowra, Bingera, and a very small portion of the Moonbi meteorites, together with a fragment from Temora. Of these, the Bingera iron was described by Prof. A. Liversidge, F.R.S., in a paper read before the Royal Society of New South Wales in December, 1880, and subsequently reprinted[*]; while in 1893 Mr. J. C. H. Mingaye, F.C.S., communicated a note on the Moonbi iron to the same Society.[†]

Until the appearance of the latest " Catalogue of the Collection of Meteorites in the British Museum, London," in 1894, the occurrence of the Cowra meteorite does appear to have been recorded. It will not be possible to refer to this catalogue again in this note, as no copy of it appears to be available in any Sydney library. As far as I am aware the only reference to the Temora appears in the catalogue of the collection of meteorites in the Natural History Museum of Vienna, that has just been published.[‡] Slices of these four meteorites were recently acquired for the Vienna collection by an exchange with the Mining Museum, Sydney. They have been examined by the distinguished specialist in charge of the unrivalled collection there (Dr. A. Brezina), who is of opinion that Bingera, Cowra, and Temora have very considerably enriched our knowledge of meteorites; they are not only of very scarce types, but one, at least—Bingera—is almost unique.

Before proceeding to refer more particularly to these meteorites, it will be advisable to give an outline of the classification adopted by Dr. Brezina. All meteorites fall into two classes, according to the relative proportions of the stony and metallic (principally iron) constituents. Those in which iron predominates are subdivided into four groups, of which the three last—the Octahedrites, the Hexahedrites, and the Ataxites, are entirely metallic. As the irons to which this paper specially refers are all classified with the Octahedrites and Hexahedrites, the other divisions will not be considered further. The members of the Octahedrite division, when etched on a polished surface, show the Widmanstätten Figures[*], in which the constituent lamellæ follow the faces of the octahedron. Those of the Hexahedral division, when similarly etched, reveal a cubic structure and cleavage.

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[*] The Minerals of New South Wales, p. 218. (8vo., London, 1888).

[†] Journ. R. Soc. N.S. Wales for 1893 [1894], XVII, pp. 82–83.

[‡] Annalen des k.k. naturhistorischen Hofmuseums, 1896, X, Heft 3 u. 4.

In the present edition of the Vienna Catalogue the classification of the Octahedrites is made to depend, as heretofore, almost entirely upon the width of the lamellæ; but it is Dr. Brezina's intention, in collaboration with Prof. Cohen, to adopt a more comprehensive scheme eventually. The present arrangement is regarded as conventional only, and the upper and lower limits of the different groups are not sharply defined. The abbreviated classification is as follows:—

I. STONY METEORITES.

A. **Achrondrites.** Groups 1–11.
B. **Chondrites.** „ 12–37.
C. **Siderolites.** „ 38–39.

II. IRON METEORITES.

D. **Lithosiderites.** Groups 40–42.

E. **Octahedrites.**
43 (Off); finest lines, lamellæ up to 0·1 mm. wide. **Cowra.**
44 (Ofv); fine lines, Victoria group.
45 (Of); fine lines, lamellæ 0·15–0·4 mm. wide. **Moonbi.**
46 (Om); medium lines, lamellæ 0·5–1·0 mm. wide.
47 (Og); thick lines, lamellæ 1·5–2·0 mm. wide.
48 (Ogg); thickest lines. Some of the lamellæ above 2·5 mm. wide. **Temora.**
49 (On); Netschævo group.
50 (Obz); breccia-like, Zacatecas group.
51 (Obc); „ Copiapo group.
52 (Oh); Hammond group.

F. **Hexahedrites.**
53 (H); normal.
54 (Hb); breccia-like.
55 (Hca); Capeisen group.
56 (Hch); Chesterville group. **Bingera.**

G. **Ataxites;** more or less structureless; groups 57–61.

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[*] The three iron-nickel alloys, upon the different resistances of which to the action of acids, and to their mutual arrangement in the mass, the etched figures depend, are kamacite or balkeneisen, taenite or bandeisen, and plessite or fülleisen. Kamacite forms "beams" which are bounded by a narrow envelope of bright taenite, the two together constituting "lamellæ" which lie in a field of dull-grey plessite, and upon the orientation of which the division into octahedral and hexahedral groups depends. While the relative proportions of iron and nickel in kamacite may be approximately taken as about 15:1, in taenite it falls to 3:1; plessite resembles kamacite in ultimate composition.

Cowra.—An iron weighing 12¼ ℔., and with a specific gravity of 7·802—a little higher than that of metallic iron. No analysis has been made as yet. This meteorite is exhibited in the Mining and Geological Museum almost intact. Portions sufficiently large to illustrate its structure are contained in the London and Vienna Collections, and will shortly be also available in America; thereby affording opportunities for the study of this rare type of meteoric iron. The credit of discovery is due to a Mr. O'Shaughnessy, who found the meteorite firmly embedded it the slate rock with only one point projecting above the ground at the summit of Battery Mountain, at the junction of the Burrowa and Lachlan Rivers, a few miles east of the town of Cowra. It subsequently passed into the hands of the District Road Superintendent, Mr. A. J. C. Single, from whom it was acquired—probably about September, 1888—for the Mining Museum by Prof. T. W. E. David, B.A., then an officer of the Geological Survey Branch of the Department of Mines. A front-view photograph, taken from an accurately-made cast by Mr. F. C. Wills, is reproduced in Plate VII, while the appearance presented by an etched polished surface is illustrated by photographs—natural size, and enlarged—in Plate VII, Figs. 1, 2.

The Cowra is classified by Dr. Brezina as a sub-group of group 43—that with finest lines—of the Octahedrites.[*] It is referred to as being of very peculiar structure.[†] The ground mass consists of thick grey plessite, in which lie somewhat porous crystals of schreibersite [‡] of considerable size, surrounded by an envelope of taenite 0·5 mm. wide. Together with these larger crystals of schreibersite there are countless small skeletons with kernels of kamacite or schreibersite apparently arranged octahedrally. For a distance of about a millimetre all round the larger schreibersite crystals the plessite ground mass is free from the little skeletons, then tiny specks of taenite appear, the little skeletons coming in gradually. Round the smaller crystals of schreibersite the ground mass is similarly clear for a distance of from one to three millimetres; then appears a ring of taenite specks, after that more clear ground-mass, and finally the thick meshwork of skeletons.

An iron of somewhat similar structure is that known as the Butler, found in Missouri, U.S.A., in 1874.

Moonbi.—Of this meteorite the Mining Museum possesses only a few shavings, it having been acquired for the Technological Museum, Sydney. An account of its discovery and composition will be found in Mingaye's paper.[§] It is an Octahedrite with lamellæ varying in breadth from ·4 to ·5 mm., thus approximating to group 46—that with medium lines; but the strong development of the plessite field leads to its being at present classed with many others in group 45—that with fine lines.[||] Grains of cohenite [¶] and kamacite are occasionally noticeable.

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[*] *Op. cit.*, pp. 235, 267, 306.
[†] *Ibid.*, p. 267.
[‡] Schreibersite is a phosphide of iron and nickel.
[§] *Op. cit.*, pp. 82, 83.
[||] *Op. cit.*, pp. 235, 268, 272, 307.
[¶] Cohenite is a carbide of iron, nickel, and cobalt.

Temora.—The Mining Museum possesses a small fragment of this iron, presented by Mr. W. A. Dixon, F.C.S. It was brought to that gentleman by a prospector during the time of the rush to the Temora diggings (about the year 1880). It appeared to have been broken off a larger mass, and was said to have been found between Cootamundra and Temora, possibly in the vicinity of Narraburra Creek. A complete analysis has not been made ; but an old label describes it as containing 95·79 per cent. of metallic iron, and 4·11 per cent. of nickel and cobalt. In addition to the piece in the Vienna Museum, there is a fragment in the private collection of Professor A. Ward, of Rochester, U.S.A. This is an octahedrite of very rare type, only one other—that found at Seeläsgen, Prussia, in 1847—being previously known. The Widmanstätten Figures are from 2 to 20 mm. wide, it thus coming under group 48—that with thickest lines, of the octahedrites.[*] Irregular beams of kamacite are separated by streaks of taenite. The kamacite is hatched and very rich in rhabdite.[†] Photographs, natural size and enlarged, are reproduced as Pl. VIII, Figs. 5 and 6.

Bingera.—This remarkable pear-shaped iron meteorite has already been described by Prof. A. Liversidge, F.R.S., as referred to above. It is now in the Mining Museum, reduced to one-third of its original size. The Vienna Collection includes a representative slice. Dr. Brezina compares it in shape to the Charlotte iron that fell at Nashville, Tennessee, U.S.A., in 1835.[‡] In structure it is almost unique, an iron found at San Francisco del Mezquital, Mexico, in 1867, alone resembling it. Unlike the Cowra, Moonbi, and Temora irons, it belongs to the Hexahedrites, coming under group 56—the Chesterville, characterised by plates of schreibersite or rhabdite, regularly orientated, and uniformly distributed through the mass. It is described in the Vienna Catalogue [§] as showing on an etched face a fine-grained zone of alteration from 1·3 to 2·5 mm. broad, extending along the whole periphery. Internally it possesses a somewhat finely granular structure, giving rise, through the different orientation of the grains, to a bright glimmering reflection (brighter than in the case of the allied Mexican iron). Numerous orientated fine lamellæ, up to 10 mm. in length, are bounded by granules, partly isolated, and partly arranged conformably to rows of schreibersite lamellæ.

From the appearance of the skin of melted material with which it is coated, Dr. Brezina considers that the Bingera was found soon after its fall.

For the photographs reproduced in Plates VII and VII, I am indebted to Mr. F. C. Wills.

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[*] *Op. cit.*, pp. 235, 288, 302.

[†] Rhabdite is a phosphide of iron and nickel, and occurs as minute tetragonal prisms arranged parallel to the edges of the cube.

[‡] *Op. cit.*, p. 294.

[§] *Loc. cit.*, p. 294.

XI.—Notes on the General and Economic Geology of the Coast between Port Macquarie and Cape Hawke: by J. E. CARNE, F.G.S., Geological Surveyor.

THE distance between Port Macquarie and Cape Hawke is about sixty miles, but following the contour of the shore-line it is, approximately, not far short of 100 miles. Port Macquarie lies about 150 miles south of the Esk and Jerusalem Creeks auriferous coast areas, which at the present time are attracting considerable attention.

Physical Geography.

The coast-line from Port Macquarie to Cape Hawke is destitute of any continuous cliff-sections, the few headlands which occur—such as Grant's Head, Camden Haven, Diamond and Crowdy Heads, Wallaby and Halliday Points, and Cape Hawke—are widely separated by long stretches of sandy beach fringing lowland areas.

The principal elevations adjacent to the coast are the conspicuous isolated mountains known as the North, South, and Middle Brothers, near Camden Haven and Stewart Rivers; and further west the Kerewong or Broken Bago Range, trending north-easterly towards Port Macquarie. Between the Manning and Wolumba Rivers, Talawahl and other peaks towards Tinonee and Coolongolook are conspicuous elevations above the general level.

The principal drainage channels entering the sea between the extreme points of investigation are the Hastings and Wilson Rivers, entering at Port Macquarie; the Camden Haven and Stewart Rivers at Camden Haven; the Manning River, with its divided outlet, at Harrington and Farquhar Inlets; and the Wollumba River, entering at Cape Hawke.

The above rivers, with their principal tributaries, drain a large tract of country lying between the Macleay watershed on the north, Cape Hawke on the south, and the high lands of New England on the west. Included in this area are portions of the Orara, Gyra, and almost all the Gloucester Gold-field, as well as the Gundle Tin-field on the Wilson River.

Between Tacking Point and Diamond Head are five lakes close to the sea-line, four of which are of considerable size. Lake Innes or Burrawan, Lake Swamp, and Cathie Lake lie nearest to the coast, from which they are separated only by swampy, sandy areas. These lakes lie opposite the long beach between Tacking Point and Grant's Head. Queen's Lake and Watson-Taylor Lake are tidal waters connected with Camden Haven River; they lie north and south of the North Brother, at a distance of about three miles apart, and one and a half from the coast.

General Geology.

The geological formations represented in the coast section consist of Carboniferous marine beds at Cape Hawke, Halliday, and Wallaby Points; fresh-water Mesozoic beds at Camden Haven, Grant's and Crowdy Heads; and Tertiary and recent deposits in the low-lying intervening areas.

Igneous rocks are represented by serpentine and dolerite at Port Macquarie, and felsite, rhyolite, and diorite at Diamond Head.

Between Port Macquarie and Tacking Point, patches of altered sedimentary rock occur in contact with serpentine and dolerite. The Signal Station at the former, for instance, stands on a peninsula of such a rock where the junction with the serpentine is well marked. The sedimentary rock, owing to intense silification induced by igneous intrusion, has in places assumed cherty, chalcedonic, and jasperoid characters.

At Nobbies, the South Head of Port Macquarie, across a narrow neck connecting the headland with the mainland, several shafts have been sunk in the altered rock where it is much decomposed. In one of them a mass of loose, rubbly quartz has been opened up, evidently under the impression that it was a vein; but a glance at the large solid masses of similar material lying at sea-level on the west side of the neck, is sufficiently convincing of its secondary character. In some instances the infiltration of the colloidal silica has converted the original rock into a homogeneous chalcedonic or jasperoid mass, in others it has reticulated it with thin seams and threads. A specially interesting example of complete silicic metamorphism is represented in some isolated rocks exposed on Tacking Point beach, at the site of the Wodonga wreck, the bedding planes of which are distinctly preserved, striking N. 52° E., and dipping N. 38° W. at 44°. Fragments of the silicified rocks and of true quartz occur loose or mingled with the deep red soil of the surface just above the beaches between Nobby's and Tacking Point, to which further attention will be given when the occurrences of gold are being considered.

Owing to contact metamorphism and absence of any palæontological evidence, the correct geological horizon of the above-described sedimentary rocks cannot be authoritatively determined at the present time, but from correlative evidence there is little doubt that they will eventually prove to belong to the Carboniferous Period.

Carboniferous Marine Beds.—Rocks of this age form the headlands at Cape Hawke, Halliday, and Wallaby Points, and a smaller unnamed headland just north of the latter, where these rocks are first seen in the coast section when followed southerly from Port Macquarie.

The strata consist of alternating beds of indurated sandstones and mudstones, with intercalated beds of coarser grits and conglomerates.

The prevailing strike at Cape Hawke—where the largest outcrop occurs—is about 1 degree from east and west. The dip is southerly, but variable in amount, ranging from 30° to 52°. At the low headland above mentioned the strike is apparently nearer north-west, but here the strata have been subjected to anticlinal and synclinal folding.

Wallaby Point consists chiefly of massive beds of indurated sandstones, grits, and conglomerates. A special feature of this outcrop is the curious concretionary weathering of some of the sandstones. Hard cores of greenish-gray colour are seen embedded in weathered yellowish-brown shaly layers from $\frac{1}{16}$ of an inch in thickness. The cores vary in size from small pellets to massive blocks, according to the thickness of the individual beds. The concretionary or rounded structure assumed in weathering probably arises from a series of parallel cross-joints or shrinkage cracks at right angles to the bedding planes, which divide the rock into blocks, and allow free access of the weathering agencies to the whole superfices, which would naturally tend to the rounding of the angles in the manner displayed by the beds in question.

From the strata exposed in the coast section, near the signal-station at Forster, Cape Hawke, a number of fossils were collected, which have since been examined by Mr. W. S. Dun, Assistant Palæontologist, who has supplied the following notes:—

"The fossils collected by Mr. Geological-Surveyor Carne, from near the Flagstaff, Parish of Forster, County Gloucester, indicate rocks of true Carboniferous age. They are mostly imperfectly preserved as casts and impressions.

Chonetes, sp. (Very closely allied to *C. hardrensis*, Phillips, of the English Carboniferous.)
Productus semireticulatus, Martin.
Spirifera. (A few specimens which indicate a species of the type of *S. grandicostata*, McCoy.)
Gosseletina australis, Eth. fil.
Fenestella.
Orthoceras. (Remains of an internal cast of a very large species, showing remains of two septa; about 7 inches wide, as preserved.)
Corals. (Very abundant; occurring as internal casts, evidently of a branching dendroid form.)
Bellerophon.
Entolium ?
Knorria.

From the neighbourhood of Cape Hawke Mr. Etheridge has already recorded *Cyrtina carbonaria* var. *australasica*, Eth. fil., *Productus cora*, D'Orb., and *Leptodomus.**"

The identification by Mr. Dun, of the fossils *Productus semireticulatus*, and *Gosseletina australis* in abundance in the Cape Hawke Carboniferous rocks is of special importance, because such forms are typically characteristic of the beds beneath the Productive Coal-Measures (Permo-Carboniferous) of New South Wales. Thin coal seams, however, do occur in the Carboniferous beds, but so far as the present state of our knowledge goes, of inferior, unworkable quality only.

Mesozoic—Clarence Measures—The cliffs forming the headlands north and south of Camden Haven and at Crowdy Head belong to this period. At the first-mentioned the strata consists of massive conglomerates and sandstones, with fine shaley sandstones and clay shales, and are specially distinguished by general horizontality and by the highly ferruginous character of the conglomerates and sandstones. The latter feature has given rise to an erroneous belief that beds of iron ore and ochre of economic importance occur here.

Crowdy Head, situated about eight miles north of the main outlet of the Manning River consists of more or less horizontally bedded massive gray sandstones, in which reed-like stems (probably *Equisetum*) are occasionally exposed during quarrying operations now being carried on in connection with the construction of retaining-walls at the entrance of the Manning River at Harrington.

The dip of the Mesozoic strata is to the south-west; at Grant's Head it amounts to about 7° only from the horizontal.

The conglomerates consist essentially of chalcedonic quartz and jasperoid pebbles in a cementing paste of sand and oxide of iron, the latter rendering some portions extremely compact and hard.

At the southern end of the south head of Camden Haven where the cliffs give place to the beach which stretches to Diamond Head, the section consists of massive beds of the conglomerate overlying a thick bed of very ferruginous clay shale, which in turn overlies a grey sandy shale containing plant remains, and a few thin streaks of coal about half an inch thick.

In a collection of plant remains from the latter, Mr. Dun determined the following well-known forms :—

" (*a*) *Thinnfeldia odontopteroides*, Morris.
(*b*) *Alethopteris lindleayana*, Royle.
(*c*) *Equisetum*.

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* Records Geol. Survey N.S. Wales, 1892, III, p. 60.

(*d*) *Cycad.* (Frond imperfectly preserved, the bases of the pinnules being indistinct. Probably a *Ptilophyllum*. *P. oligoneurum*, Ten. Woods, occurs in the Ipswich Coal-Measures of Queensland.)

(*e*) *Gleichenites?* There is also present a fern with small lobate pinnules, somewhat similar to *Didymosorus* (*Gleichenites*) *gleichenoides*, Oldham, from the Rajmahal Coal-Measures, (Lower Mesozoic), of India, but differing from it in the distance apart of the pinnæ and their less bead-shaped and more elongate form but it is very indistinctly preserved. This species (Indian) has been also described from the Desert Sandstone of Croydon, Queensland.

(*f*) *Cardiocarpum.*

(*g*) *Phyllotheca* sp. This form is unlike any that has hitherto been described from Australian Mesozoic rocks. It is characterised by the very elongate fine leaf bracts, and the narrow stem. It is of the type of *Phyllotheca deliquescens*, Schmalhausen, from the Jurassic of Western Russia, and *P. sibirica*, Heer, from rocks of similar age in Siberia."

The fossils identified establish the Mesozoic age of the rocks on the coast at Camden Haven, and, therefore, point to the possibility of strata of the Productive Coal-Measures (Permo-Carboniferous) underlying them. This question will, however, be further considered under the head of coal.

Igneous Rocks.—I am indebted to Mr. G. W. Card, A.R.S.M., Curator of the Mining Museum, for the following petrographical notes on igneous rocks from the localities mentioned:—

[819] 53-mile peg—Port Macquarie to Taree Road. Ophitic dolerite (olivine absent.)

[820] First point south of Nobby's, near Port Macquarie. Similar to 819, but coarser in grain.

[821] Tacking Point, (by some regarded as granite, J.E.C.) Similar to 820, but less ophitic in structure and much altered. Would appear to be of considerable geological age.

Note.—These three [819, 820, 821,] would be termed diabase by some. The absence of olivine brings them somewhat nearer the diorites.

[823] Diamond Head. Diorite.

Mr. Card also confirmed my field determinations of the Diamond Head quartz felsites, and the silicified fine-grained sedimentary rock already described.

Economic Geology.

The economic metals and minerals represented in or near the coast-line between Port Macquarie and Cape Hawke consist of gold, copper, cobalt, manganese, iron and limestone, which will be dealt with in due order, and followed by reference to the reported occurrence, and probable existence of coal and kerosene shale.

Gold.—Gold naturally first claims attention, not, however, because of any importance attaching to the beach-mining operations which have hitherto been attempted. It occurs in reefs at Coolongolook, and Paddy's Creek, near Bungwall, west, and a little south-west of Cape Hawke, in rocks of Lower Carboniferous age. In Bunt and Ort's Claim, at Paddy's Creek, the gold-reefs occur as thin flat-lying veins in conglomerate, which caps at this point the claystones and slates in which the neighbouring reefs occur. At Coolongolook the gold reefs are thin and have been mostly characterised by the occasional occurrence of very rich, but extremely small shoots; a mode of occurrence usually if not invariably leading to loss and disappointment. The regular persistence of good stone with depth in the Curriki Reef should, however, encourage prospecting at lower levels. Coming nearer to the sea-beaches, gold in the matrix, or more correctly, loose gold derived from local matrix, has been found in fairly coarse pieces, at intervals, between Nobbies and Tacking Point, near Port Macquarie, where, as before stated, igneous and sedimentary rocks occur in contact. The gold is here found in the red soil and rubble which covers the surface and accumulates as small taluses at the foot, of the elevated land at the back of the beaches. In December last, a local resident, Mr. A. Wade, pointed out several localities further inland where prospects were obtainable.

Both the igneous and sedimentary rocks, as before mentioned, are seamed with small veins, chiefly of a secondary or chalcedonic silica, in which pyrites is rarely seen. From a few of the most favourable-looking, samples were taken, which, however, failed to reveal the presence of gold on assay. That the gold obtained under the conditions stated differs distinctly in character and derivation from the uniformly minute particles in the beach sand, is easily apparent to those who occasionally find it when trying the latter at the junction of the red soil.

The indications in this locality point to dissemination of gold in small quantities through the country rather than concentration in defined matrices or reefs. The loose gold of the red soil probably represents the naturally concentrated yield of a large amount of weathered and denuded country.

At Diamond or Indian Head, two distinct intrusions of igneous rock occur in conjunction, the oldest consisting of diorite, and the younger of quartz-felsite. Rhyolite occurs in the latter, filling an irregular fissure, through which it has welled up in well-marked lines of viscid fluxion structure.

On the surface of the quartz felsite, crystalline quartz veins occur, having a maximum thickness of from one to one and a half inches in thickness; the apices of the crystals are free, symmetrical, and perfectly transparent, hence, perhaps, the name of "Diamond" Head. Pyrites is associated with portions of the country and some of the veins. The discovery of the quartz veins and pyrites caused a small rush to the locality, and a number of shallow shafts and trenches were sunk on the top and western falls of the head-land, but the indications are decidedly unfavourable both as regards the character and permanence of the veins.

Marine denudation has exposed the quartz felsite to a depth of three to four hundred feet in the coast section without revealing any favourable mining indications. It is true that the felsitic intrusion in its composition is allied to the Pambula auriferous rock, more especially as regards the very thin and limited rhyolitic bands; but this approximate resemblance counts for nothing unless gold occurs in the mass itself, which there is at present no ground for assuming.

Beach Gold Mining.—So far as could be ascertained, remunerative beach-mining has only been possible in about three localities between Port Macquarie and Cape Hawke, viz., Tacking Point Beach, Camden Haven, and Harrington Inlet; and even in these cases for very limited periods and yields only. The most important—Harrington Inlet—yielded about £70 worth of gold before the supply of material was exhausted. Messrs. Atkinson and Hannay discovered the deposit about fifteen months ago just north of the retaining wall now being constructed. The auriferous sand extended for about four hundred yards along the shore-line at, and near, sea-level. The bluish layer of "sniggers," averaging from four to fifteen inches in thickness, rested on altered sandstone, and filled its numerous joints and crevices.

On Tacking Point Beach, near the "Wodonga" wreck, Osbiston Brothers last year worked a "snigger" deposit for a reported yield of twenty ounces, which exhausted the present supply of workable sand. The best results were obtained from the deepest layers, which averaged from one to two inches in thickness under from five to ten feet of stripping. This party had just removed to Camden Haven Beach, where at the most rations were formerly made.

Messrs. Woods and Partner have cut a race about one and a half miles long, taking advantage of the course of a small creek which trends northerly behind, and parallel to, the coast dunes, for the purpose of ground-sluicing a deposit of sand close to Tacking Point. At the head of the race a small conserving dam has been constructed, from which the water had just been turned on, the volume being about equal to two sluice-heads. On the beach, plates and boxes have been laid on the sand, coir matting and blanketing are both used for lining the boxes and the bed of the race above the plates. Judging from the altogether ineffective fall of the water and its consequent gentle silting effect on the plates and boxes—which were almost entirely buried beneath the drifted sand, and the extreme liability to damage by even moderately high tides and gales, nothing but failure can be predicted for this venture, even if the deposit is a payable one, which has yet to be demonstrated. A little of the blanketings or concentrates supplied by one of the party—which, however, was not regarded as altogether a fair sample—yielded no trace of gold in the Departmental Laboratory. This evidence is only an indication of poverty not of complete absence of gold, for the gold particles being free might—if few—be missed in sampling.

At Nobbics a few pot-holes have been sunk for gold amongst rounded boulders and pebbles, but with what result is not known. A noticeable feature is the association of well-worn pebbles and shingle with the auriferous black sand in almost every instance where it occurs on the beaches.

In June, 1894, a prospector named Warbrick began testing the sand inside the Old Bar, at the entrance of the south channel of the Manning River, at Farquhar Inlet. His operations attracted attention, and caused a small rush of about thirty men; few, however, remained after a short interval. The only protracted trial being that of Messrs. Crofton and Party, who worked intermittently for about seven months, their chief efforts being concentrated in a small depression about seventy-five yards back from the beach, close to the border of the mainland. Here the sinking is about seven feet, in dry, clean, sand; the bottom consists of stiff pug-clay, with pebbles derived from the conglomerate beds of the country. The black sand layer exposed in the bottom of a shaft sunk at the time of inspection averaged from ten to thirteen inches in thickness. The same party also worked for a time on the beach opposite the Recreation Pavilion. Holes sunk at this spot as deep as the water would allow revealed extremely fine thin layers of black sand, alternating with ordinary white quartz sand. In working, however, the whole available thickness of black and white layers would have to be operated on, because separation would be impossible. Shovel-panning of selected samples yielded a few very minute gold specks, but no platinum.

Evidences of the existence of earlier beaches landwards.—In two localities, viz., Tacking Point Beach, north of the outlet of Cathie Creek, and the beach near the outlet of Khappinghat or Saltwater Creek, between Wallaby and Halliday Points, there is evidence of Recent and Tertiary sea-made areas extending inland. At the foot of the beach dunes in these localities, a hardened black sand-bed occurs about, and a little above, sea-level, consisting of ordinary quartz sand, grains coloured and cemented by organic matter and iron salts. The essential differences between these and similar occurrences in the Esk River District are the extreme poverty of the present beaches opposite these outcrops, and the conspicuous rarity of the genuine black sand (titanic iron and zircon) which forms such a common and characteristic feature of the more northern auriferous beaches. In fact, this constant associate of the gold particles becomes markedly less and less discernible as the coast line is followed southwards from Port Macquarie.

It is true that Osbiston Brothers reported a yield of twenty ounces of gold for twelve months' work from a patch of natural concentrates or "sniggers" on Tacking Point Beach, just about the north end of the "black rock" outcrop; but opposite the outcrop itself no good results were obtainable.

At the other locality mentioned, near Saltwater Creek outlet, the "black rock" rises in some places to a height of six feet above the beach level, and through it fresh water is continuously soaking from the made ground at the back. A feature of this outcrop is the occurrence in it of large, altered sandstone pebbles, mostly in layers, which would render testing by sludger extremely difficult, if not impossible.

Iron salts play an important part in the colouration of this bed, and where such have been converted into peroxides at the exposed outcrop, the rock is of a yellowish or reddish-brown hue.

On the banks of Saltwater Creek outlet, and for a very limited distance south, thin layers of the true black sand occur. An average sample taken carefully from the surface layers—which cake as they dry in the sun—yielded a trace of gold only when tested in duplicate in the Departmental Laboratory. From the position of the true black sand at the base of the loose sand of the dunes, and its marked absence on the beach opposite the long outcrop of "black rock," it would appear as if it were derived from the former.

A large swamp closely parallel to the beach south of Old Bar was regarded by some as evidence of a former encroachment of the sea, but a very slight test was sufficient to disprove this conjecture.

I am indebted to Mr. Hannay, of Taree, for the following particulars of the nature of the sinking about two hundred yards inland from the mouth of Abby Creek between Diamond and Crowdy Heads:—

Wind-blown sand	2′ 6″
Boulders and sand with fine gold particles	2′ 0″
Chocolate-coloured slimy sand	6′ 0″
Coarse gravel with coarse colours of gold regarded as bottom	......

Three men were engaged here partly in trying the beach sands at the creek mouth, and partly in prospecting in the neighbourhood.

Absence of Basalt-covered Drifts.—In the strip of country under consideration there is apparently an entire absence of basaltic outflows covering earlier drainage channels. The original richness of the sea beaches adjacent to such phenomena in the Richmond and Tweed River Districts, and their gradually but surely increasing poverty in ratio with the distance from those localities, adds immensely to the importance of the drifts as a source of the beach gold, and to their undoubted influence on the richness of adjacent beaches.

In a previous report* I dealt with the question of the origin of the beach gold. The opinion therein expressed has been strengthened by phenomena observed during recent examination of beach areas further south. Such an opinion, however, can be but a tentative one, to be confirmed or rejected by future detailed survey and observation. The tests being carried out at the present time in the Tertiary and Recent sea-made areas, under the able and careful supervision of Mr. D. Munro, should afford valuable data for future guidance.

Metals other than Gold—Cobalt Ore.—Nine or ten years ago cobaltiferous manganese oxide (Wad) was discovered by Mr. E. H. Becke, at Nobbies, Port Macquarie, which attracted some attention because of the establishment at Sydney about that date of works for treatment of ore of a similar composition from near Bungonia (where it occurs as a cementing material, and in small concretionary nodules, in a coarse grit); but the nature of the ore, its chief mode of occurrence being thin coatings, stainings, and encrustations in the joints and divisional planes of serpentine, renders it extremely doubtful whether any form of mechanical treatment could be successfully adopted. The ore was first detected in the serpentine country at Windmill Hill; and street cuttings and levelings reveal its presence in the town of Port Macquarie itself.

Iron Ores.—With the cobalt ore is associated a little magnetic iron ore, which, in some places, is altering into soft red iron ochre (red hematite), having a deceptive appearance to some of the uninitiated, who are apt to mistake it for cinnabar. The rich red colour of the neighbouring soil is most probably due to the above chemical or molecular change.

At Tacking Point, at the foot of the cliffs on the south side, magnetite occurs as a crust of no great thickness, which, when broken, reveals an altered rock highly charged with pyrites.

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* Ann. Rept. Dept. Mines and Agric. N.S. Wales for 1895 [1896], pp. 149–160; see also *postea*, pp. 71–86.

At Honeysuckle Flat, close to the 43-mile peg on the Port Macquarie-Taree Road, magnetite occurs as gravel, both loose and in fairly large cemented lumps. Its physical character is very deceptive, causing it to be readily mistaken for ordinary brown iron ore (limonite). The occurrence is in a low flat of serpentine country, which here has a width of about twenty-five chains. The iron-ore gravel has doubtless been shed from the serpentine, and concentrated and partly cemented in a swampy area; judging from the road trenches, the deposit appears to be very superficial.

Copper.—About twenty-five years ago attention was directed to a deposit of copper and iron sulphides at Nobbies, Port Macquarie, and a shaft was sunk, but evidently without satisfactory result, for operations were not continued. A few broken specimens, chiefly of iron sulphide, near a later opening, is all that is now visible, hence no opinion can be offered.

Copper ore is also reported from Hanging Rock, about three miles west from Green Hills, but this site, through inadvertence, escaped attention.

Coal and Kerosene Shale—Reported Discoveries.—Local reports are current as to several separate discoveries of coal and kerosene shale, generally in loose pieces. About three years ago Mr. A. McLeod reported finding loose specimens of kerosene shale on Broken Bago Range, which resulted in four sections of land being applied for by a Sydney mining agent; later, these areas were re-applied for; but in neither case does actual prospecting appear to have been done. Loose drifted specimens of kerosene shale are also reported from near Saltwater Creek, at some distance from the coast.

Coal has been reported from the headlands at Camden Haven, and substantial accounts given of burning tests. These headlands, as already stated, consist of Mesozoic rocks. Whether a coal-seam does actually outcrop beneath them at or below sea-level I am not prepared to dispute, because I did not follow the headlands completely round their sea-face, being blocked in one instance by the sea, and in the other by the approach of night. It is probable, however, under the circumstances, that the reported coal was from the thin coal-streaks near the plant-beds already described in this report.

The identification of Secondary (Clarence) beds at Camden Haven and Crowdy Head opens up an interesting question relative to further extension of our already extensive coal-basins. Looking at the Broken Bago Range, from Wauchope, attention is at once arrested by the bold, vertical, western escarpments of the range towards Mounts Kerewong and Combine, a feature which affords reasonable presumption for the existence of horizontal beds, and which is strengthened by the later determination of Mesozoic strata on the coast at Camden Haven. The isolated Brother Mountains will also probably prove of this period. The coast outcrop is of little importance, because of its limited extent; but greater scope is afforded by the Broken Bago Range, which, if proved to belong to the same period, may overlie productive coal-measures. A special detail examination would be necessary to determine this interesting and important question.

XII.—Additions to the Permo-Carboniferous Coal-measure Flora of New South Wales: by W. S. DUN, Assistant Palæontologist.

[Plate IX.]

THE characteristic and protean genus *Glossopteris* appears to become more bewildering in accordance to the number of specimens examined; in fact, as has already been pointed out by Mr. R. Etheridge, Junr., the whole question, both as regards generic rank, specific characters and synonymy, is now most hopelessly involved.* As far as the Australian forms are concerned the species already described number eighteen, and nothing but the marked dissimilarity of the two forms herein mentioned would warrant the establishment of two new species to a list of which probably half the specific names are invalid and the generic uncertain.

II.—Descriptions.

Glossopteris, Brongniart, 1828.

(Prodrome Hist. Veg. Fossiles, p. 54.)

Glossopteris rectinervis, sp. nov.

Sp. Char.—Leaf elongate-lanceolate, midrib strongly marked, secondary veins very reticulate, fine, leaving the midrib almost or quite at right angles. Reticulations irregular, meshes long and narrow at centre between midribs and margin, not elongate, but small along the margin. Apex unknown. Stalk unknown.

This species is very different from any other form occurring in the Australian or Indian Plant-beds, so much so that it seems advisable to consider it as a distinct species, as it would not fit in as a variety of any hitherto described leaf. It cannot be compared to any New South Wales form, unless we can imagine *Glossopteris parallela*, Feistm,† on a much smaller scale, with the venation springing at right angles from the midrib.

As far as the direction of the veins is concerned, attention may be drawn to the condition obtaining in *G. divergens*, Feistm.,‡ though it differs from *G. rectinervis* both in outline and mode of anastomosis of the veins. The direction of the secondary venation also resembles that of *G. divergens* in being, at the base, directed downwards, at the centre of leaf at right angles, and towards the apex, more upwardly.

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* Proc. Linn. Soc. N. S. Wales, 1894, IX (2), pp. 228-249.

† Mem. Geol. Survey N.S.W., Pal. 3, 1890, t. 18, f. 3.

‡ Pal. Indica, Ser. XII, Vol. III, Flora of the Damuda and Panchet Divisions, 1881, p. 104, t. 28O, f. 3, 4.

The outline agrees somewhat with that figured by Feistmantel [*] in a specimen of *G. damudica*, Feistm., but the same differences, separate *G. rectinervis* from this species as from *G. parallela*.

But the greatest resemblance to a member of the Indian Gondwana Flora appears to be in *G. stricta*, Bunbury, from the Raniganj Group. [†] In general form, apart from the greater size of *G. stricta*, there is very little difference; but Feistmantel, in describing the reticulation in the Indian form, speaks of it as passing " out from the midrib at a pretty acute angle." This form has been recorded by the same Author from the Beaufort Beds of South Africa. [‡]

The specimens of this species were collected by Mr. C. Cullen, at the Ward River, County of Gloucester, in beds belonging, most probably, to the Upper or Newcastle Coal-Measures. The Coal-Measures occur here as small outliers, and have been described by Professor T. W. E. David as being referable to either the Newcastle or Tomago Coal-Measures, or possibly to a combination of the two. [§]

(*b*) *Glossopteris acuta*, sp. nov.

Sp. Chars.—Leaf imperfect, base not shown; elongate, acute, delicate; apex pointed; midrib fairly strong; reticulations inclined at an angle of about twenty-five degrees with the midrib, about five in the space between the midrib and margin; reticulations approaching to margin in some cases; nerves in some cases joined by well marked cross-bars as well as the reticulations.

This is an exceedingly graceful form of leaf, and cannot be assigned as a variety to any hitherto-recorded species of *Glossopteris*. Its most characteristic feature is the extremely acute and apparently delicate apex.

In by far the greater majority of cases the apex of *Glossopteris* is rounded, and as an instance of a more pointed apex we may take *G. indica* as figured by Feistmantel, [||] though this is typical in being rounded, and not acute as in our species. The venation is, on a small scale, like that of *G. conspicua*, Feistm., [¶] of the Raniganj Group. It differs from the same Author's figures of Brongniart's *G. augustifolia* [**] in the form of the leaf, the lesser development of the midrib, and the arrangement of the reticulation.

The specimen is preserved in fine grey laminated sandstone, and was obtained by Mr. E. F. Pittman in the first Cremorne Bore, at Robertson's Point, Sydney, at a depth of 2,900 feet. in the Newcastle or Upper Coal-Measures.

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[*] *Loc. cit.*, t. 31 a., f. 1 (non. 2 and 3.)

[†] *Op. cit.*, p. 100, t. 37a, f. 1 & 2.

[‡] Abhand. K.B. Gesell. Wissensch., 1889, Folge VII, Bd. III, p. 45, t. 4, f. 6, 6a.

[§] Ann. Rept. Dept. Mines N.S. Wales for 1889 [1890], pp. 219-221.

[||] Pal. Indica. III, t. 27a, f. 3.

[¶] *Op. cit.*, t. 28a, f. 1.

[**] *Op. cit.*, t. 39a., f 1, 1a, 2,

XIII.—Mineralogical Notes, No 5: by GEORGE W. CARD, A.R.S.M., F.G.S., Curator and Mineralogist.

1. Telluride of Bismuth from Tarana and Uralla.
2. Martite from Byng.
3. Apatite from Gordonbrook.
4. Jamesonite from Bolivia, New England.
5. Prehnite from Dapto.
6. Chromite in Felsite from Barraba.

1. *Telluride of Bismuth from Tarana and Uralla* :—At Tarana the mineral was first noticed by Mr. E. C. Whittel, Field Assistant, at Mitchell and Party's Claim near Slippery Creek. It occurs along with free gold in small grains and flakes in the quartz, and is associated with greenish and yellow alteration products. The Telluride is most probably auriferous.

A similar mineral has recently been found, also associated with free gold, in a white quartz from Kentucky Run, near Uralla. Telluride of Bismuth has been previously recorded from Captain's Flat, Molonglo, and from Moor Creek, Tamworth.

2. *Martite from Byng* :—Iron-grey sharply defined octahedral crystals, up to two millimetres in length, having a purplish-red streak, embedded in a soft yellowish-green soapy matrix which is traversed by strings of massive iron pyrites having an unusual tarnished appearance. Crystals of similarly tarnished pyrites also occur in the matrix itself.

3. *Apatite from Gordonbrook* :—Pinkish-white crystals associated with an actinolitic substance, described as occurring in narrow veins traversing granite. The crystals have the form of the di-hexagonal prism, and vary in size up to an inch across. With the exception of the minute crystals common in certain igneous rocks, apatite has hitherto been recorded in New South Wales from Broken Hill only, where it is associated with galena.*

4. *Jamesonite from Bolivia, New England* :—Jamesonite is now being found both massive and intimately associated with galena, at the Pye's Creek silver-lead mines. Its mode of occurrence is peculiar, in that it appears to be replacing galena. Lumps of the galena may be seen surrounded by a layer of, and traversed in all directions by strings of jamesonite, being in this way broken up into irregular fragments. An average sample of such a specimen yielded on assay seven per cent. of antimony, and forty ounces of silver to the ton.

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* A. Liversidge, Journ. R. Soc. N. S. Wales for 1895 [1893], XXIX, p. 316.

5. *Prehnite from Dapto*:—In the excavations being made at Dapto for the works of the Smelting Company of Australia large masses of prehnite, sometimes associated with crystals of quartz, are found.

6. *Chromite in Felsite from Barraba*:—At Crow Mountain Creek, Barraba, the serpentine country rock has been traversed by felsitic dykes. The felsite is dotted over with specks of chromite, or contains spots of pale green chrome-bearing silicate of magnesia. Under the microscope the chromite grains are sometimes seen to be broken up and drawn out into contorted bands by the flow of the viscous lava. It would appear as if the intrusive material had eaten its way into the serpentine, partially assimilating the latter. The chromite grains being more indestructible remain more or less intact.

XIV.—On the Occurrence of the Genus *Chelodes*, Davidson and King, in the Upper Silurian of New South Wales: by R. ETHERIDGE, Junr., Curator of the Australian Museum, Sydney.

THE remains of Chitons in the Palæozoic, and for the matter of that also in the Mesozoic rocks of Australia, are conspicuous by their absence. Recently Mr. Charles Cullen, Collector to the Geological Survey, obtained two fossils from the Upper Silurian Series of Yass, agreeing in outline with the hitherto somewhat problematical plates knowns as *Chelodes*, Davidson and King, and its allies *Sagmaplaxus*, Œhlert, and *Beloplaxus*, Œhlert.

Chelodes has been ascribed at different times to a *Chiton* by Barrande, a provisional Brachiopod by Lindström, an Operculate Coral by Davidson and King, an *Aptychus* by Von Jhering, and lastly relations have also been suggested with the Cirripedia. More recently, however, Dr. G. Lindström has reconsidered the whole question, and after reading his clear exposition of the case,* it seems to me that the balance of evidence, as he suggests, is in favour of a reference to the Chitonidæ.

The fossils comprised within the three genera lately mentioned may be broadly stated to be oblong, trigonal, or subtrigonal angular plates, generally longer than broad, and arched (*Chelodes*, *Sagmaplaxus*), convex on the dorsal surface, concave on the ventral; or, although convex on the former, grooved in the middle line (*Beloplaxus*). The anterior end is broad, more or less truncate, and to a greater or less degree emarginate centrally, with the lateral anterior angles either rounded

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* Sil. Gastropoda and Pteropoda of Gotland, 1884, p. 48.

(*Chelodes*, *Sagmaplaxus*), or sharp (*Beloplaxus*). On the other hand the apical or posterior end is strongly developed, acuminate, and terminating in an obtuse, or semi-obtuse point. The dorsal surface in all three bears growth lines or laminæ, concentric with the outline, but the ventral in all three is divided into two unequal portions. In the case of *Chelodes* and *Sagmaplaxus*, an anterior end of variable outline according to the genus, and a posterior that presents the appearance of a raised area, broadly V- or chevron-shaped, regarded by Lindström and Œhlert as an area of insertion. It is this peculiar space that probably suggested to the former of these authors, in the first instance, the reference of *Chelodes* to the Brachiopoda, by recalling the area of a ventral valve, or to the Lepadidæ by suggesting the "beak" of the tergum. *Beloplaxus*, on the contrary, has no broad chevron-shaped area on the ventral aspect, but instead, straight surfaces along the lateral borders from behind forwards. In the genera *Chelodes* and *Sagmaplaxus* at least, the edges of the plates are turned under, forming a narrow thickened border.

The most important feature about these plates, however, is that, unlike the generality of *Chiton* plates, they are all destitute of apophyses, and only in *Beloplaxus* has any trace of insertion plates been observed.

Both *Sagmaplaxus* and *Beloplaxus* were described* by Dr. Daniel Œhlert as the plates of Chitons, but Lindström believes that *Chelodes* and *Sagmaplaxus* "may be considered as ranging very near to each other," but judging merely from the figures, I am inclined to generically separate them.

Chelodes is typified by *C. Bergmani*, D. and K., from the Wenlock rocks of Gotland, and is there associated with a second species, *C. gotlandicus*, Lindström. In the Upper Silurian of Bohemia we meet with *C. bohemicus*, Barr. *Sagmaplaxus* and *Beloplaxus* are Devonian, the former (*S. sarthacensis*) coming from rocks of that age in France, the latter typified by *Chiton sagittalis*, Sandberger, from those developed in Nassau.

The Australian fossils (Woodcut, p. 70) I now refer to *Chelodes*, as the most fitting of the three genera for their reception, are silicified, thick, elongate (longer than wide), subtriangular, claw-shaped plates, arched, or obtusely geniculate in the longitudinal middle line, slightly curved from front to back, and with sharply sloping sides. The anterior margin is subtruncate and emarginate centrally, rounded at the sides, forming rather obtuse angles with the posterior lateral margins, which converge to a fairly acute posterior apex. Internally or ventrally the shell is divided into two unequal parts, as in *C. Bergmani* and *S. sarthacensis*, of which the anterior is by far the larger. The posterior area of imbrication is strongly chevron-shaped, the wings extending forwards as far as the angles formed by the junction of the posterior and antero-lateral margins. There is no striation or ridging apparent on this imbrication area, whilst the external sculpture of the whole dorsal surface is confined to indistinct traces near the anterior emargination of concentric laminæ of growth.

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*Mém. Soc. Géol. France, 1881, II (3), No. 1. pp. 15 and 17.

The plates differ rather in shape, one being much broader than the other, with its imbrication area varying accordingly. In neither of them is there any trace of an inturned border as described both by Lindström and Œhlert.

It will be manifest that as the plates are not grooved by a median sinus for the greater part of their length, nor a linear imbrication area, the genus *Beloplaxus* may be dismissed from discussion. Of the two other genera, I have selected *Chelodes*, from its general resemblance to the Yass plates, although the latter appear to be much stouter and more arched and massive than either of the three known species of *Chelodes*, although the formation of the imbrication area is the same. The latter character equally points to *Sagmaplaxus*.

In the absence of apophyses or sustentacula, the present plates agree with *Chelodes Bergmani*, *C. gotlandicus*, *C. bohemicus*, and *Chiton? cordatus*, Kirkby,* as well as *Sagmaplaxus* and *Beloplaxus*, and differ in this respect from the recent *Chitons*, and a large number of the other Palæozoic forms also.

The outline of the Australian plates differs widely from the recent Chitons, except, perhaps, such forms as *C. hastatus*, Sby., as pointed out by Kirkby and Lindström, *Ichnochiton alatus*, Sby., and *Schizochiton incisus*, Sby., &c., and many fossil species, although there are some which are similarly shaped. Amongst the latter may be mentioned certain species of *Pterochiton*, Carp. (*Rhombichiton*, De Kon.), for if the apophyses of these be removed, the resemblance is very strong, even the imbrication area in *Pterochiton* becoming very much wider and more triangular, reaching its greatest development in *P. gemmatus*, De Kon.

Lindström is undoubtedly correct in stating that the V- or chevron-shaped space at the posterior end of these plates is the overlapping area of the valves, and he considers it homologous with the linear area on the inside posterior end of recent Chiton plates, and " seems hardly to have received all the attention it deserves."

I have termed this the area of imbrication, and fail to see how it can be regarded as an area of insertion, a term used by several Writers. It must be borne in mind that the insertion areas proper are found on the cephalic and anal plates of recent and most fossil Chitons, being extensions of the articulimentum, as are the apophyses likewise. Salter remarks† that the inflected portion of each plate below the apex diminishes in size according as the plates are more closely pressed against each other.

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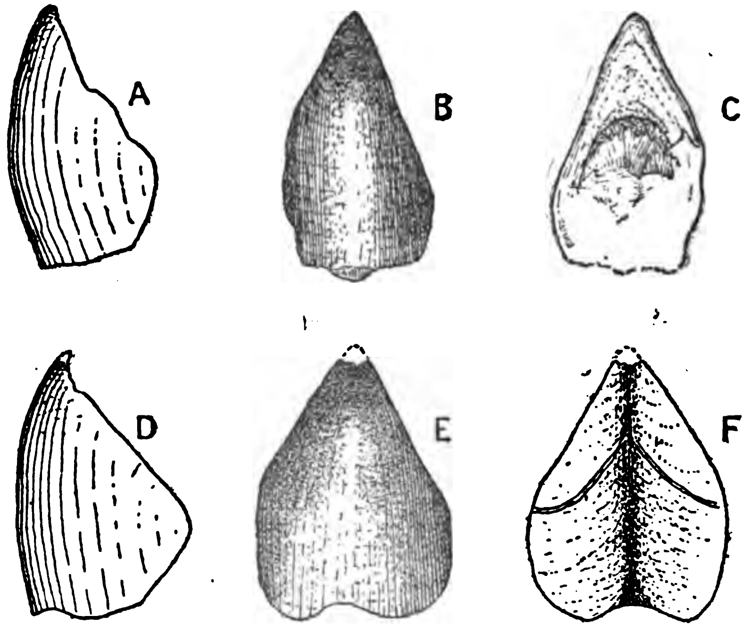
* Quart. Journ. Geol. Soc., 1859, XV, t. 16, f. 25, 26.
† Quart. Journ. Geol. Soc., 1847, III, p. 50.

The plates from Yass probably belong to the intermediate series, and are all tegmental, there being no articulimental portion here. A perusal of Salter's interesting remarks on *Helminthochiton* will leave very little doubt as to the intermediate position of the present pieces, or as he terms similar ones, dorsal.

The plates of *Chelodes* were probably ranged in linear series like those of *Helminthochiton*, for I think we may conclude that such was the case in the latter, judging from the very slightly displaced position of those originally figured* by De Koninck. Woodward now believes *Solenocaris*, Young and Young, to be a Chiton, and has figured a similar line of plates†. Furthermore, if the inflected area below the apex of each plate diminishes with close adpressure of the plates against one another, as Salter says it does, then it follows that the plates of *Chelodes* must have reposed in a more or less separate state from one another, in the girdle or zona of the mantle.



To these interesting plates I purpose applying the name of *Chelodes calceoloides*. They were obtained by Mr. Charles Cullen, at Portion No. 1 of 635 acres, Parish of Derringullen, County of King.

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* Bull. Acad. R. Belgique, 1857, III (2), t. 1.

† Geol. Mag., 1885, II (3), p. 357.

XV.—The Auriferous Beach Sands of the Esk River and Jerusalem Creek, in the Parish of Esk, County Richmond, New South Wales, by J. E. Carne, F.G.S., Geological Surveyor.

I.—Previous Mention.

In 1894, Mr. Geological Surveyor Stonier reported on the auriferous sands near the Evans River, about eight miles north of Jerusalem Creek, and briefly alluded to the locality now under consideration.[*]

In 1880, Mr. E. F. Pittman, A.R.S.M., examined the auriferous beach-sands between the Richmond and Tweed Rivers.[†]

In 1889, Mr. C. S. Wilkinson, late Government Geologist, described those near the Richmond Heads, as well as the auriferous basalt of the same locality.[‡]

In 1892, Mr. J. C. H. Mingaye, F.C.S., Analyst to the Department of Mines, read a paper "On the occurrence of gold, platinum, and tin in the beach-sands of the Richmond River District."[§]

A detailed description of the methods of working the beach-sand will be found in the Annual Report of the Department of Mines for 1895.

II.—Physical Geography.

The Parish of Esk, with the exception of its north-west corner, where the dividing range between the Clarence and Richmond coast waters crosses it, consists of a tract of level forest land, merging gradually into broad, marshy, almost treeless flats, along the sea-coast which forms its eastern border. It is difficult to define the boundary between the sea and land-made deposits, because the loose sand derived from the weathering of the massive sandstone of the adjacent high lands on the west, is mingled with the sea-worn sand which has been drifted inland by the action of the wind. It is clear, however, that numerous shallow inlets of the sea penetrated at one time well inland towards the dividing range; but there is not sufficient ground for the belief entertained by some of the miners, that the foot of the present range represents the original shore-line prior to the deposition of the auriferous sands. Between the range and the coast (a distance of about nine miles due west from McAuley's Lead), the sandstone bed-rock can be seen *in situ* on the low ridges and in road cuttings; the most eastern outcrop noticed being about three miles east of the Halfway House.

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[*] Ann. Rept. Dept. Mines and Agric. N.S. Wales for 1894 [1895], pp. 129-131.
[†] Ann. Rept. Dept. Mines N.S. Wales for 1880 [1881], p. 245.
[‡] Ann. Rept. Dept. Mines N.S. Wales for 1889 [1890], p. 203.
[§] Journ. R. Soc. N.S. Wales for 1892 [1893], XXVI, pp. 368-370.

The coastal country between the Clarence River and Jerusalem Creek Heads, is enclosed on the west, in semi-circular form, by the dividing range, as far south as Tobbimoble; and thence easterly by high lands to the Clarence Heads. The bay-like appearance of this low area, partially enclosed by a rim of high land, doubtless gave rise to the belief above stated as to its marine origin.

III.—Geological Features.

The geological formation represented in the coast country between the Clarence and Richmond Rivers, consist almost entirely of Clarence (Triassic) Coal-Measures. Mr. Stonier describes a small outlier of slate at Bullock Creek, between Jerusalem Creek and the Evans River, as probably of Lower Carboniferous age; but this classification is based solely on stratigraphical position.

About half-a-mile south of Evans River Heads the coast section exposes a massive escarpment of sandstone with conspicuous current bedding, overlying sandy shales containing a seam of inferior coal, about one foot thick, just above high-water mark. The high downs of this locality are formed of the above sandstone, large bosses of which are seen outcropping at intervals. The highest beds of the dividing range west of the Esk River, also consist of the same massive sandstone; these form the middle beds of the Clarence Coal-Measures, and are regarded as the geological equivalent of the Hawkesbury Series.

Igneous rocks are represented by a felsitic dyke which intrudes the Coal Measures just south of the Evans River. From the strike of this dyke it is extremely probable that the very reef on which the ill-fated "S.S. Cahors" was wrecked (about two miles south-easterly), is a hard boss of the same rock which has resisted the wearing action of the sea more successfully than the enclosing shales and sandstones.

On the dividing range at Tobbimoble and near Double-duke Peak, south-west of the Esk River, two small isolated patches of basalt have so far been recorded. These are of special interest as they indicate a considerable southern extension of the volcanic flow so largely represented north of the Richmond River.

IV. Discovery of Gold in the Beach-sands.

According to Mr. D. Munro of Ballina—who is well known as a most observant and careful recorder of geological and other phenomena—gold in payable quantity was first discovered in beach-sand in New South Wales, at Shaw's Bay near the North Head of the Richmond River, by John Sinclair in March, 1870, who obtained twelve ounces of gold in a fortnight. The publication of this return caused a rush, and drew New Zealand beach-miners to the spot with the appliances which experience had proved most suitable under similar conditions on the West Coast of the South Island of that Colony. Though thirty years have elapsed since the commencement of beach-mining in New Zealand, blanket, carpet, or cocoa-nut matting covered tables have not been superseded. Dredges have been tried on the beaches unsuccessfully. Little hope of success with dredges is expected until the principle adopted by the miners is used in connection therewith.*

From the date of Sinclair's discovery to the present time, the beaches of the North Coast have given employment to many. Periodically large numbers find remunerative work for several months in the year. Mining on the present beaches will, however, always be of an intermittent character, because of its dependence upon the occurrence of south-easterly gales to break up fresh portions of the terrace of black sand rock, which is exposed for miles along the coast just beneath the loose sand-dunes, and to concentrate the heavier particles on the surface of the beaches into what are locally called "sniggers". The lower portions of the loose white sand-dunes fringing the coast also contain particles of previously liberated gold, which help to enrich the concentrates accumulated in workable form during stormy conditions.

Mr. Munro states that the richest patches recorded in the early workings were found on the southern side of the headlands, which is in conformity with the greater force exerted at such points by the prevailing winds, viz. south-east. The localities recorded by the same authority as being specially distinguished by their original richness are Tallow Beach, south of Byron Bay; Seven Mile Beach, south of Broken Head; Black Rock Beach; and the beach south of Evans Head. From these localities gold valued up to £800 per man were obtained in periods ranging from six to nine months.

For a considerable time past little actual beach-mining has been done owing to the absence of any gales of consequence. North of Jerusalem Creek auriferous deposits have been worked some distance back from the beach on areas of some elevation above sea-level. As the occurrence of the auriferous sands under such conditions in this locality has formed the subject of a special report by Mr. Stonier (already quoted), the present detailed description will be restricted to the more recent discoveries in the flat lands further south.

M'Auley's "Lead."† In March 1895, Messrs. Alexander and Angus M'Auley discovered the lead which bears their name, and to them belongs the credit of the first discovery of payable gold in the "black rock" at a distance from the present beach, but not, as is frequently stated, for the first discovery of gold inland from the sea-line.

The lead occurs on the east face of a low, narrow sand-dune, which trends parallel with the coast line for several miles. For a long distance the lead keeps uniformly on the eastern face, but near the north end it underlies it. Its trend, so far as traced, is about north and south, and the distance from the coast about three-quarters of a mile.

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* Papers and Reports relating to Mining in New Zealand, 1893, p. 120.

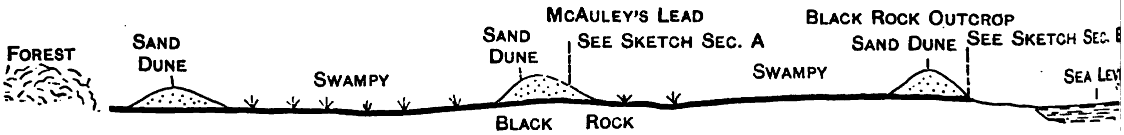
† The term "lead" is adopted in this report because of its local use; the auriferous wash, however, has been deposited by the action of the sea on an earlier shore-line, and not by a fluviatile stream.

The sand-dunes—several of which occur between the coast and the Esk River—are about three hundred feet wide, and from ten to fifteen feet above the general level. Locally they are known as "terraces"; this term, however, has a local significance, differing from the ordinarily accepted meaning of the term in mining. About M'Auley's Lead and Jerusalem Creek, it simply denotes long, narrow windrows of loose white sand parallel to each other and the coast; and separated by areas of low marshy ground covered with stunted vegetation, chiefly speargrass.

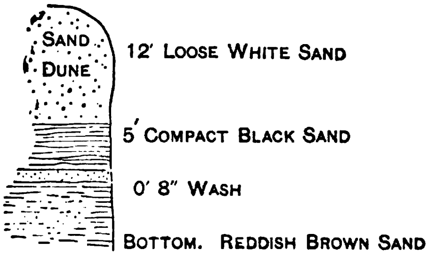
The "black rock" cropping out along the present coast line on a uniformly level horizon indicates a prior extension of the swampy conditions seawards, and a subsequent encroachment of the sea. But whether the slight elevation of the surface of the black rock represents an elevation of the land or depression of the sea-bed, or simply an accumulation of sand thrown up by stormy conditions, sufficient data is not yet to hand to enable a determination being arrived at.

The following rough section of the country between the sea-coast and the edge of the forest land west of M'Auley's Lead, will give a fair idea of the so-called terraces, and possibly suggest a mode of formation. If the most western dune or terrace be regarded as approximately the position of an earlier shore line of a broad, shallow estuary, the middle terrace may be regarded as the probable site of a sand-bar which gradually shut off the sea-water; the land drainage and rainfall into the intervening area would gradually tend to render the impounded shallow sea-water brackish, and subsequently fresh; whilst the suspended matter would form nutriment for swamp vegetation, the decay of which has coloured all the underlying beds, so far as tested, to a more or less degree of blackness.

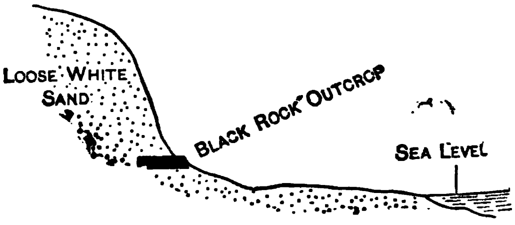
A repetition of similar conditions would account for any number of dunes or "bars" to suit the circumstances.



SKETCH SEC. A
MCAULEY'S LEAD



SKETCH SEC. B
OUTCROP BLACK ROCK



One of the small sections represents the outcrop of the "black rock" on the coast, along which it forms a most marked feature; and the other the nature of the sinking at M'Auley's Prospecting Claim; the latter being to scale. At this point, however, the over-burden of loose white sand is exceptionally heavy, as the lead here is under the terrace.

A short distance north from M'Auley's the terrace takes a turn to the eastward, and swampy conditions prevail in the direct line of strike. At this point the lead has been lost, and a considerable distance intervenes between its north end and the next nearest workings which are known as Coolgardie. The connected line of claims which form M'Auley's Lead proper extends for a distance of about two miles.

Since M'Auley's discovery the terraces have been followed as guides in prospecting; but it is doubtful whether their present positions can always be regarded as having been permanent since the first accumulation of the loose sand forming them, for the prevailing wind must tend to move them forward in the direction of its course. This objection applies only to the loose sand above the compact or swampy conditions, in which the inequalities would be permanent. The bend to the eastward, north of M'Auley's Claim, may be due to the protection afforded by the higher sand-dunes on the shore line opposite to, and a little south of, this point, which intercept and modify the force of the wind; whilst the unprotected terrace further south would tend to move bodily in a more or less straight line. Hence, there is every reason to expect to find in the level swampy areas between the terraces other old shore lines twelve feet deep. At this level the compact black sand—locally identified as the "black rock"—is met with, and five feet below its surface the auriferous layer is reached. Underlying the wash is a layer of reddish-brown sand, which is regarded as bottom. At the west side or back of the lead the auriferous layer forms but a thin streak, which thickens gradually on the underlay seawards. Its richness decreases proportionately with the thickening, and the overburden becomes correspondingly heavier. Hence, the width of the workings represents the payable limit of the wash following the underlay. This fact holds good for the whole lead, the workable width of which, under present conditions, varies from about fourteen feet to thirty feet.

The richest portion of the wash lies well up on the sloping bottom of the lead, just as do the "sniggers" of the present beaches after south-easterly gales. The gradual cessation of the gales and recession of the waves tend to draw off the lighter particles down the sloping surface of the beach, leaving the heavier stranded beyond the reach of normal waves, Nature thus performing on a gigantic scale the panning of the miner.

In a number of claims—Williams and Party's, for instance—two layers of auriferous sand occur, separated by about three inches of barren sand, the auriferous layers in this instance being six inches and ten inches thick. The intervening barren sand increases in thickness in some claims—as at Keats and Party's—to about two feet.

About twelve inches above the top of the black sand is a layer of varying thickness known as the "blue seam," which carries colours of gold, this colour of the layer being due to the distribution of black sand particles through the pure white. This "seam" represents very probably æolian concentration on the surface of the compact black rock. The concentrating action of the wind by removal of the lighter particles of quartz sand is seen to advantage any windy day on the sea beaches; at a distance the wind-borne particles have the appearance of dust. In this way large areas of beach surface, covered with a thin superficial layer of the heavy black sand grains, have been completely sifted of the lighter quartz particles which were left entangled by the waves.

In the black rock above the wash very black thin bands occur at intervals, one very characteristic one (about one inch thick) just above the wash. These are exceedingly hard, most likely owing to the precipitation of an iron salt by organic matter.

In October last there were but four claims at work north of M'Auley's Lead. In the most northern—Wilson and Bourke's—the stripping is very heavy; about sixteen inches of wash is said to underlie it.

As before stated, north of this point a break in the lead occurs, extending for at least a mile. Up to this point the "terrace" has run a true course nearly north and south; here it takes an easterly bend. If, as there is reason to believe, the lead represents an earlier shore line, a sinuous bend partly round a projection seawards, or following an inshore encroachment, may naturally be expected, which may account for the loss of the lead at the north end of M'Auley's, irrespective of the contour of the terrace; on the other hand, the lead may yet be found on its course under the swampy land, and ultimately connect with the Coolgardie lead, which lies in the same general direction.

South from M'Auley's Claim the lead, with few exceptions, is being worked in a continuous line of claims for about one mile and a half. The richest portion, however, lies north towards the prospecting claim.

Prospecting has been extended for a considerable distance south of the most southern workings but without success, gold being obtainable, but not in payable proportion. In this direction the wash shows a considerable thickening, accompanied by a corresponding depreciation in richness. In M'Auley Brothers' Claim, at the extreme south end, the auriferous layer is three feet six inches thick and the approximate width twenty feet. An attempt was being made to work about two feet of this wash.

Coolgardie Lead.—This lead is situated on the west side of Jerusalem Creek. Three claims only were at work, but active prospecting was proceeding between it and the mouth of the creek. A number of claims have already been worked out north of the above lead.

The most interesting feature about the Jerusalem Creek mines, and one of hopeful import to the field, is that several distinct runs of gold-bearing sand have been proved in the swampy flats as well as in the terrace. In the swampy ground the sinking is from nine feet to twelve feet. The runs of wash vary in thickness from one foot to two feet by a width of about twelve feet. Water stands within about three feet from the surface.

Close to the head of Jerusalem Creek the gold is obtained from about two feet of white sand just above the black rock, the best yield being from a seam about three inches thick directly above the latter. The underlying black rock has been tested to a depth of twelve feet, but nothing beyond colours was obtained; this, however, appears to have been a single test.

North from Jerusalem Creek the coast country loses its level character, and changes from marshy land traversed by low parallel sand-dunes to very undulating country, covered with high dunes irregularly disposed. Between the sand hills fresh water channels trend from the adjacent high lands in the west. At intervals large basin-shaped depressions occur, also filled with fresh water. Along the shore line high narrow sand-dunes extend, the leeside of which affords capital camping ground for the itinerant miners who periodically visit the locality after stormy weather to work the "sniggers" or concentrates formed by the action of the high waves. In October, however, this locality was practically deserted owing to the superior attractions of M'Auley's Lead and the absence of gales.

All the workings on the high-levels back from the beach in this neighbourhood have been in the loose white sand.

During my inspection small quantities were selected from the tailing heaps of at least two-thirds of the claims on M'Auley's Lead for the purpose of obtaining, by assay, a general idea of the loss in the first part of the treatment. In like manner small quantities of the concentrates, after amalgamation, were secured; from the general average of these samples the following results were obtained under the supervision of Mr. J. C. H. Mingaye, F.C.S., Analyst and Assayer to the Department:—

[4138] Mixed tailings from about two-thirds of M'Auley's Lead Claims—

Gold	2 dwts. 14 grs. per ton.
Silver	1 dwt. 7 „ „
Metallic tin	0·05 per cent.

No platinum or platinoid metals detected.

[4139] Concentrates from about two-thirds of M'Auley's Lead Claims, after amalgamation—

Gold	2 ozs. 19 dwts. 3 grs. per ton.
Platinum	0 „ 18 „ 17 „ „
Iridosmine	under 15 „ „
Metallic tin	5·12 per cent.

[4270] Tailings from Hammond, Dowling, and Party's Claim—

Gold	3 dwts. 19 grs. per ton
Silver	3 „ 19 „ „

No platinum or platinoid metals detected.

[4269] Concentrates from Hammond, Dowling, and Party's Claim, after passing three times over amalgam plates—

*Gold	15 ozs. 1 dwt. 12 grs. per ton.
Platinum	2 „ 18 dwts. 3 „ „
Iridosmine	0 „ 17 „ 7 „ „
Metallic tin	28·52 per cent.

The following assay results, obtained in the Department's Laboratory †, are quoted to show the extent to which concentration, on a small scale, has been carried on as regards the metals other than gold, and the tin oxide. Unfortunately, these returns afford no data of value, as particulars are not available as to the quantities of wash operated on.

With the exception of No. 1251, these samples were, presumably, concentrated in the ordinary manner by frequent passage over carpet-covered tables. The exception was the result of manipulation in a small experimental machine constructed by a Mr. R. Young, but nothing is known of the principle.

[245] Concentrated beach sand from Ballina—

Platinum	428 ozs. 9 dwts. 4 grs. per ton.
Iridium	26 „ 16 „ 16 „ „
Osmiridium	161 „ 13 „ 20 „ „
Other platinoid metals	2 „ 16 „ 11 „ „
Gold	2 „ 19 „ 12 „ „

[1251] Beach sand from the Richmond River district, concentrated by Mr. R. Young—

‡Gold	70 ozs. 4 dwts. 16 grs. per ton.
Platinum	36 „ 5 „ 4 „ „
Iridium	8 „ 6 „ 14 „ „
Iridosmine	6 „ 0 „ 18 „ „
Other platinoid metals	4 „ 8 „ 2 „ „
Metallic tin	25·7 per cent.

[2690] Concentrated beach sand, containing some amalgam from the Richmond River district—

Gold	100 ozs. 18 dwts. 7 grs. per ton.
Platinum	68 „ 0 „ 4 „ „
Osmiridium	8 „ 18 „ 23 „ „
Iridium and other platinoid metals	2 „ 1 „ 19 „ „
Metallic tin	28·96 per cent.

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* Chiefly from amalgam which escaped from the plates.

† Ann. Rept. Dept. Mines and Agric. N. S. Wales for 1894 [1895], p. 57.

‡ In this case it is known that none of the gold got had been removed by amalgamation before concentration.

[2879] Concentrates from J. Ware's Claim, Richmond River District—

Platinum	129 ozs.	9 dwts.	16 grs.	per ton.
Osmiridium	58 „	0 „	7 „	„
Iridium and other platinoid metals	5 „	0 „	7 „	„
Gold	0 „	9 „	11 „	„

[3499] Concentrated beach sand from between Richmond River Heads and Byron Bay—

Platinum	7 ozs.	13 dwts.	22 grs.	per ton.
Osmiridium	1 „	6 „	0 „	„
Other platinoid metals	0 „	3 „	6 „	„
Gold	0 „	9 „	18 „	„
Metallic tin	15·82 per cent.			

Composition and characteristics of the wash.—High specific gravity, fineness of component particles, and colour, are the physical characteristics which immediately arrest attention.

The specific gravity of a sample of the wash from M'Auley's Claim carefully determined by Mr. Mingaye was 4·42, that of the average concentrates of the lead after amalgamation 4·22.

An attempt was made to estimate the proportion of quartz sand in the natural wash by means of a gravity solution, viz., borotungstate of cadmium which has a density of 3·28. With the exception of a few grains which remained in suspension, the whole of the sample settled at the bottom of the tube; from which it may be inferred that the proportion of quartz is very slight, as indicated by the high specific gravity (4.42).

On warming a little of the wash with distilled water the solution gave an acid reaction with litmus paper. On roasting at a low heat in the open, the organic matter and colouring were readily burnt off, which opens up the question as to the relative advantages of roasting and solution. To effect thorough combustion of the organic matter by roasting open hearths or plates lightly spread charges and frequent raking will be necessary. The two processes are equally effective as far as cleansing the sand grains is concerned; roasting, however, removes the peaty particles which would remain practically untouched in the solution; this does not, however, affect the equal value of the solution process, as the peaty fragments would not interfere with amalgamation. The question therefore, resolves itself entirely into one of relative cost. After roasting in the open it was found that the major portion of the titanic iron could be removed by magnetic separation. Briefly stated the wash is composed chiefly of small zircons—mostly uncoloured—ilmenite (titanic iron), quartz, garnets, tinstone, and varying proportions of gold, platinum and platinoid metals. The hardness (7·5) and highly crystalline character of the zircon sand suggests the possibility of its utilization for the preparation of an improved variety of sand-paper.

The fineness of the component particles of the wash will be easiest comprehended from the results achieved in sizing tests, which are given in the following abstract:—

Sizing tests.

Locality.	Nature of Material.	Weight of Sample.	No. 1 screen. 900 holes to sq. inch.	No. 2 screen. 3,600 holes to sq. inch.	No. 3 screen. 8,100 holes to sq. inch.	Passed through No. 3 screen.	Remarks.
			Remaining.	Remaining.	Remaining.		
M'Auley Bros. Claim	Wash (specific gravity, 4·42)	1,734 gr.	....	(*a*) 17 gr.	709 gr.	1,015 gr.	A little peaty matter was previously extracted from this sample by No. 1 screen. (*a*) Lost 2·82 gr. on ignition.
M'Auley's Lead (Assay No. 4,139)*	Average concentrates after amalgamation. From two-thirds of the claims on the lead	2,000 „	....	58 „	425 „	1,517 „	On No. 1 screen, a few peaty particles. On No. 2 screen, chiefly quartz sand. On No. 3 screen, a few colours of free gold visible.
Hammond, Dowling, and Party's Claim, M'Auley's lead (Assay No. 4,269)*	Concentrates after passing three times over copper plates	1,000 „	....	....	129 „	871 „	No. 3 screen—Numerous gold particles on this screen. No. 3 screen—Practically all tinstone passed through.
O'Dwyer's Claim, do.........	Platinum concentrates.........	653 „	....	3 gr.	39 „	611 „	No. 2 screen—Amalgam. No. 3 screen—Platinum and gold showing on this screen.
Shellharbour, south of Wollongong (Assay No. 4,327)†	Concentrates	1,298 „	36·5 gr.	35 „	109 „	1,117·5„	No. 1 screen—7½ per cent. of metallic iron scale; balance, ferric and titanic oxides. No. 2 screen—Chiefly quartz, mag. iron, ferric oxide, and ilmenite. No. 3 screen—Quartz, colourless zircon, mag. and ferric oxides.
Richmond River District	Concentrated platinum (clean sample)	74 „	....	....	1 „	73 „	No. 3 screenings—Amalgamated gold and a little ilmenite.

* For results of these assays see page 78 *antea*.

† This sample yielded
- Platinum...... 30 oz. 10 dwt. 18 gr. per ton.
- Gold .... 1 „ 15 „ 22 „ „
- Tin .... 40·01 per cent.

Payable leads beneath those at present worked.—So far as could be ascertained very few attempts have been made to test the sandbeds beneath the present wash level. In some of the very few test holes below the bottom of the leads colours of gold have been found. It appears very probable that deeper leads exist, but the possibility of working below a stripping level is not very bright, unless the yield be high. The presence of permanent water, with impossible drainage and porous and treacherous ground, requiring powerful pumping machinery and close timbering or boxing, would render working very costly.

Derivation of the gem sand and associated metals and metallic minerals.—As might be expected, considerable diversity of opinion exists as to the source of the precious metals in the sands of the north coast beaches. Some regard the adjacent coast ranges as the original repository; others surmise the existence of auriferous reefs beneath the sea parallel with the coast line; whilst others, regardless alike of distance and opposing currents, look even so far as the West Coast of New Zealand, where similar auriferous sands occur. The theory of precipitation from sea water is also not without its advocates.

For the sake of comparison it is interesting to note Sir Julius von Haast's description of the alluvial workings on the West Coast of New Zealand. The earliest found and most elevated of the drifts rest on terraces composed of Marine Tertiary strata where they have escaped denudation by the streams descending from the mountains. The second group of gold diggings are those in the beds and alluvial terraces of streams which intersect the first mentioned leads. Third, the beach terraces which extend to an altitude of two hundred and twenty feet, and mark several changes in the level of the shore line within a comparatively recent geological period. In this group also must be classed the gold deposits formed on the present coast line by the action of the surf and currents, which distribute along the shore the gold brought down by the streams.* As detailed geological survey proceeds, the interesting problem of origin presented by the north coast auriferous beaches will doubtless receive practical demonstration; in the meantime the following possible sources may be discussed:—

(*a*) The underlying Siluro-Devonian rocks.

(*b*) The Clarence Coal-Measures, particularly the basal and middle beds of the Series.

(*c*) Early drainage channels, represented by drifts under basalt.

(*d*) The auriferous (?) basalt at the Richmond River Heads.

(*e*) Present drainage channels from the eastern margin of the auriferous and stanniferous rocks of New England.

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* Mining Statements and Goldfield Reports, New Zealand, 1893, p. 156 By Authority.

In considering the above suggested sources it is essential that the enormous spread of the auriferous sands along the coast should be kept prominently in view. From near the Queensland Border to Port Macquarie at least these sands have been worked; and even as far south as Shellharbour, south of Wollongong, similar sands occur, and have received a little attention. The distance between the extreme points mentioned is about five hundred miles. In considering the probability of any restricted source, such as the Ballina basalt, it must also be remembered that the trend of the coast current is southerly.

The break in the continuity of the auriferous sand along the coast, between the main southern (Shellharbour) and the nearest northern (Port Macquarie), will, perhaps, eventually be accounted for by the difference between the geological formations of the watershed between these points and those opposite the auriferous beaches.

(*a*) The underlying Siluro-Devonian rocks developed on the north coast, between Broken Bay, near Ballina and Sutherland Point, near the Tweed River Heads, contains numerous quartz reefs. In a few instances assays up to several pennyweights of gold per ton have been obtained from the most favourable; but the average results have not exceeded two pennyweights per ton. Mr. E. F. Pittman, after an examination of the auriferous beaches between the Richmond and Tweed Rivers, came to the conclusion in the year 1880 that the black sand and gold evidently come from a drift (underneath the basalt) derived from the underlying older rocks (Siluro-Devonian).*

The basalt referred to touches the coast about Ballina at the Richmond Heads, where it overlies the Clarence Coal-Measures, hence any drifts directly underlying it having the above deviation must have been transported from the Siluro-Devonian area on the north. The drift becomes additionally important if, instead of restricting its source to the underlying rocks, we regard it as evidence of exclusive channels which, prior to the basalt outflow, drained from the high auriferous and stanniferous areas to the west. This extension of the source of the drift would account for the large proportion of the gem sand and the tinstone which are invariably associated with the gold and platinum metals in the beach sands; neither of which could be reasonably assigned wholly to the Siluro-Devonian sedimentary rocks.

(*b*) The Clarence Coal-Measures form the surface rocks along the coast from a little north of Ballina to nearly opposite Solitary Island, a distance of about eighty miles south. The auriferous character of these measures is based upon the discovery of gold in minute specks in the Hawkesbury Sandstone (which is regarded as the equivalent of the middle beds of the above measures) at North Shore and Govett's Leap, by the Rev. W. B. Clarke,* and recently by Professor Liversidge in the same beds at Pyrmont, and in the overlying Wianamatta shales in the University Grounds, Sydney†. The basal conglomerate of the Clarence Coal-Measures, so far as is known, has not been tested. This bed has an extensive outcrop along the western margin of the coal basin, where a thickness of several hundred feet rests directly on the auriferous Siluro-Devonian slates and sandstones of the eastern falls of the New England Tableland. Where exposed in creek sections the conglomerate and intercalated coarse grits are generally very friable; frequently quartz pebbles are abundant, the bulk, however, being slate and granite. Considering the nearness of the Dalmorton, Mann River, and Sclferino reefs, and the junction of the stanniferous granite, it is reasonable to expect to find at least traces of gold, tin, and gem stones in a conglomerate formed from the wearing down of such rocks. Through the kindness of Mr. W. J. Mulligan, of O. B. X. Creek, about twenty miles from Grafton, I have been able to test, by panning off, about fifty pounds of this conglomerate; but, contrary to expectation, none of the above-mentioned minerals were detected. The test, however, can only be regarded as a superficial one. Though gold has been determined in the Hawkesbury Series, there is no record of platinum ever having been detached.

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* *Loc. cit.*, p. 245.

The basal beds of the Clarence Measures have an additional interest inasmuch as beds of similar age and geological horizon have recently identified by Mr. E. F. Pittman, Government Geologist, as containing artesian water at Moree.

(*c*) *Drifts under basalt.*—This possible source has already been alluded to under section (*a*). Basalt is extensively developed as a surface rock between Ballina and Casino; thence north-westerly up the channel of the Richmond River to Roseberry Station, and from there north-easterly to the coast at Point Danger.

Another outcrop trends north from Casino to Fairy Mount, and from there north-east to the Valley of the Tweed, where it joins the first-mentioned.

The isolated patches of basalt at Tobbimoble, and near Doubleduke Peak on the dividing range of the Clarence and Richmond coast waters afford indisputable evidence of a southern extension of the Richmond basalt sheet, or of a similar flow now almost entirely removed.

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* Southern Goldfields, pp. 44 and 244 (8vo). Sydney, 1860.

† Journ. R. Soc. N. S. Wales, 1894, XXVIII, pp. 185-8.

Under the Tobbimoble basalt patch, which is now but ten to fifteen feet thick, resting on Hawkesbury Sandstone, quartz, pebbly, and granular drift occur, which has been prospected by three or more shafts, a little gold being obtained. From selected samples fine colours of gold and a little of the characteristic gem sand of the beach wash were obtained. Tobbimoble lies about ten miles south-west of M'Auley's Lead.

The extensive basalt flows of the Richmond and Tweed Districts in all probability filled up the pre-existing drainage system from the western tablelands, and this would, as before stated, account for the composition of the beach sands, formed from denudation of the old channel debris.

(*d*). *Basalt as a Source of the Gold.*—According to Mr. Munro, gold was first reported in decomposed basalt at Black Head, near the town of Ballina, in February, 1888. The only other record of the occurrence of gold in basalt ascertainable is that recently announced by Mr. J. Collett Moulden, A.R.S.M., from Kangaroo Island off the south coast of South Australia.* Professor Tate in an editorial note states that the basalt referred to occurs as an intrusion in mica schist. The specimen microscopically examined by Mr. Moulden contained a small speck of gold embedded in it which might have been caught up from a reef in the intruded schist.

The late Government Geologist, Mr. C. S. Wilkinson, described the Ballina occurrence in the following terms:—"The town of Ballina, which is immediately within the river entrance from the ocean, is situated on the flat; but the north head of the entrance consists of a small hill of dense black basalt and blown sand. About half a mile further north is the Black Rock (Head), a perpendicular cliff thirty feet high, facing the ocean, and composed at the base of hard dense basalt, then a bed four to ten feet thick of scoriaceous volcanic agglomerate, overlaid by fifteen to twenty feet of hard dense columnar basalt; above this is about thirty feet of soft decomposed laminated basalt.

"Mr. Munro informed me that from the lower agglomerate bed several parcels had been treated in Sydney—one of over 3 tons yielding at the rate of 2 dwt. 10 gr. of gold per ton, and another of 19 cwt. yielding 18 dwt. 11 gr. of gold per ton; a total of about 7 tons 17 cwt. treated gave an average yield of 12 dwt. per ton. These beds have a slight dip inland, and could be easily worked. There is no doubt that the gold and platinum in the sand and gravel on the beach, which has for years past been worked to the north and south of Black Rock, have been derived from the denudation of the basalt, the rippling action of the ocean surf tending to throw back the gold with the black sand and shingle drift about high-water level."†

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* Trans. R. Soc. S. Austr., 1895, Vol. XIX, Pt. I, pp. 71-72.

† Ann. Rept. Dept. Mines N.S. Wales for 1889, p. 203.

Mr. Wilkinson personally selected samples from the 4-ft. bed in Jones' shaft—from the top 1-ft. layer of the lower 8-ft. bed, from the top bed thirty feet thick and from lower 7-ft. level—all at Black Rock. In only one of these samples was the Departmental Analyst, Mr. Mingaye, able to detect even a trace of gold.

Mr. Wilkinson also selected samples from the same basalt sheet near Lismore; in none, however, was gold detected.

Whilst recently at Ballina I also selected a sample from the agglomerate, and later on Mr. Munro forwarded a larger sample. In both instances care was taken to break away the seaworn face, and to take only the freshly exposed material. Large duplicate assays and panning tests failed to detect the presence of gold in either sample.

The value of the discovery is greatly discounted by the conflict between the numerous fire assay results and those obtained by mechanical treatment from bulk parcels, a statement of which, through the kindness of Mr. Munro, is here given.

Statement of Crushings of Basalt from Black Rock, Ballina.

Where treated.						Yield per ton.			Remarks.
		tons	cwt.	qrs.	lb.	oz.	dwt.	grs.	
Sydney Mint		0	17	1	16	0	15	6	From sea-face, lower seam.
Parke and Lacy	2	3	8	0	10	0	2	12	„ „ „
„ „		1	18	3	15	0	12	13	From drive in lower seam.
„ „	3	0	19	1	3	0	18	11	„ „ „ 20 to 30 ft.
„ „		0	14	1	16	0	9	18	From top or surface seam.

The above parcels were despatched in three lots at different dates in 1888.

Were it not for the yields from the two parcels obtained from drives in the lower seam (one of which is stated to have been from twenty to thirty feet in length), the discrepancy between the assay and bulk crushing results might be accounted for by the accidental occurrence of gold in the exposed scoriaceous agglomerate face at the foot of the Black Rock, the vesicular cavities of which would act as small riffle holes as the auriferous sand of the coast is dashed against it by the wash of the waves which continuously reach it, save at low tide. That gold-sands have been perpetually dashed against this bed is undoubted, because of the occurrence of one of the richest patches of beach-sand just on the north side of the Black Rock.

The presence of gold in the decomposed basalt forming the soil on the top of the cliff just below the lighthouse (where the discovery was first made) does not weaken the above solution of the question, because the wind-blown sand mentioned by Mr. Wilkinson has at one time extended over the top of the basalt at this point; a little of it even now remains. As it was drifted away by the wind a few fine gold particles would remain on the surface of the decomposing basalt, and would slip into sun-cracks and joints, and thus account for the surface prospects obtained. It is unaccountable why such favourable prospects obtained from bulk samples have not been followed up.

The gemsand and tinstone, which are such uniformally persistent associates of the gold and platinum of the beach-sands, can hardly have been derived from the basalt, even if the gold was. A quantity of the crushed basalt was carefully panned, but no trace of any enclosed gem-stones could be seen under the microscope; even if these had been present in quantity their presence would, perhaps, be best accounted for by accidental engulfment in a basalt overflow.

(*e*) *Present drainage-channels from the eastern margin of the auriferous and stanniferous rocks of the New England Table-land.*—These channels have a precipitous watershed from the above formations, and short courses to the ocean. They are very subject to flooding in rainy seasons, the currents at such times being swift and powerful. The lower stretches of these rivers have little fall, and here the heavier burdens from the precipitous upper reaches are dropped, whilst only the finest particles are swept on to the sea.

Where the watershed is formed of rocks differing from those mentioned above (as west of Sydney, where the Hawkesbury Series, and the Permo-Carboniferous Measures form the high lands) the characteristic auriferous sand is absent from the coast beaches.

Taking all these facts into consideration, it seems most probable that the earlier drainage channels (represented by the drifts under the basalt flows), and the present surface streams, have been and are the feeders of the auriferous beaches. The early drainage channels probably first began the work of transporting the sand to the sea, which is now being carried on by the present drainage system. Owing to the extreme fineness of the particles the powerful currents of these old torrential rivers—like the present—were able to overcome the high gravity of the component minerals, and sweep them on to the ocean, where they encountered an opposing current and the shoreward sweep of the waves. Since the basalt flow filled up these early rivers, and turned the waters into new channels, atmospheric denudation has been steadily wearing away the volcanic cover, and bringing the imprisoned drifts again within the transporting influence of rain and stream to the further enrichment of the beaches.

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PLATE VI.

Syringothyris exsuperans, *De Koninck*, *sp.*

Fig. 1. Conjoined ventral and dorsal valves, showing the high and wide area, small channelled and incurved umbo, and open delthyrium in the former; and the fold and costæ in the latter. Greenhills.

Fig. 2. Similar specimen, showing the slits left by the dental plates, and the arched "transverse plate." Greenhills.

Fig. 3. Internal cast, somewhat crushed and distorted, showing the slits left by the decomposition of the dental plates, with a wider arched "transverse plate" in the ventral valve; and the fold with the impression of the septum and lateral costæ in the dorsal valve. Parish of St. Aubin.

Fig. 4. Reverse of Fig. 3, exhibiting the wide and inner slits of the dental plates, muscular impressions, and coarse costæ of the ventral valve.

Fig. 5. Internal cast of the ventral valve of a smaller individual, displaying the slits of the dental plates, area, and delthyrium. Parish of St. Aubin.

Fig. 6. The area of Fig. 5.

Fig. 7. Punctate shell structure, seen on the lateral slopes of another specimen. Greenhills.

Drawn from nature by Mr. P. T. Hammond.

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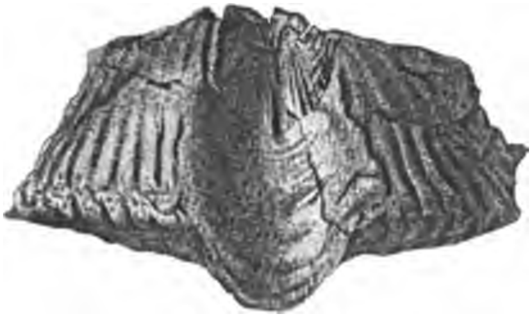

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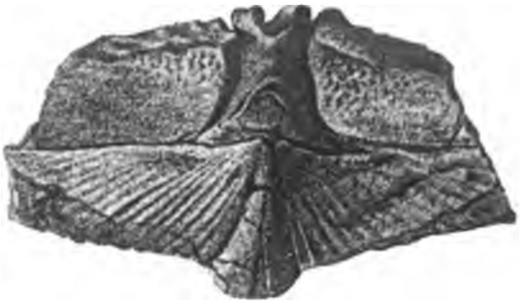

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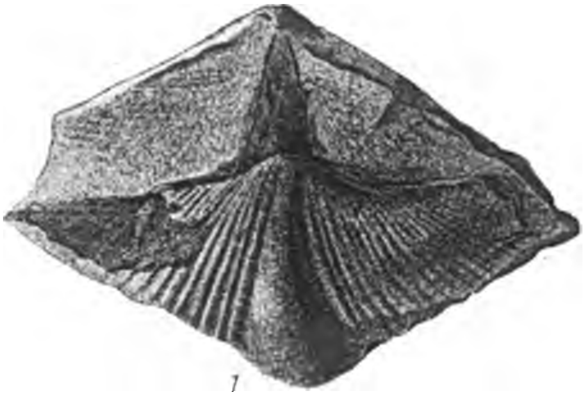

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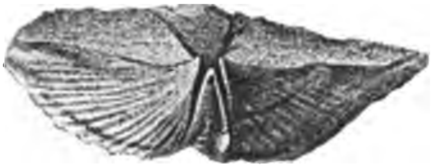

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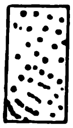

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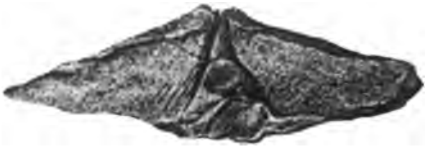

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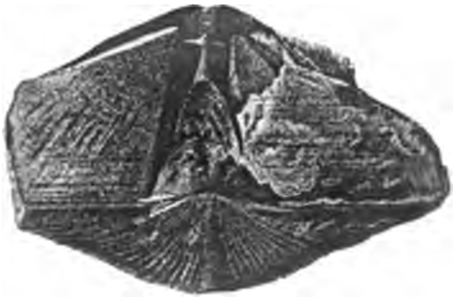


2

P. T. Hammond, del.

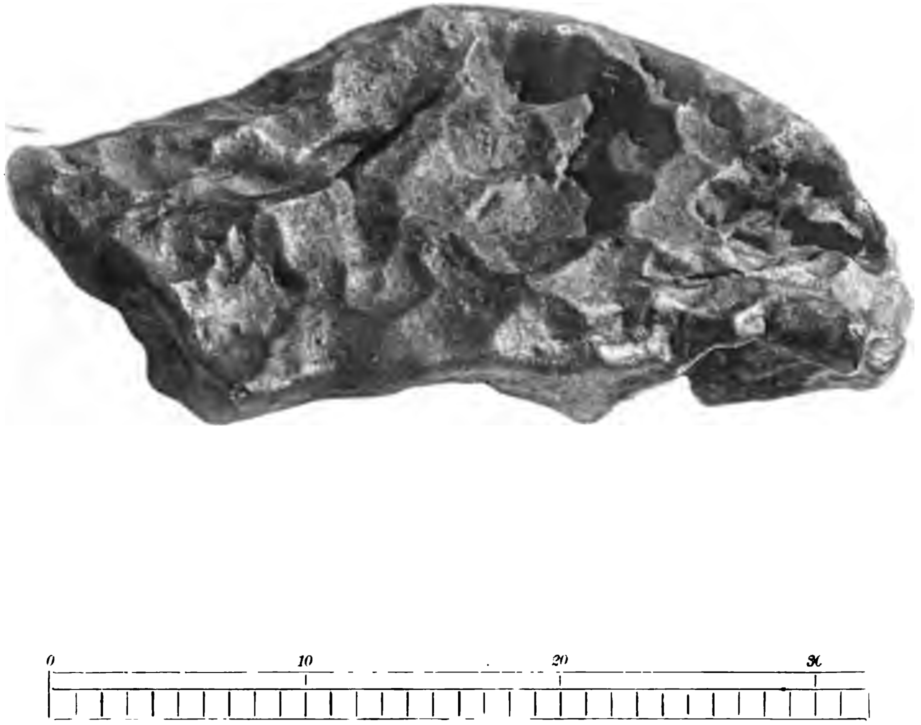
Heliotype.

PLATE VII.

The Cowra Meteorite: front view.

From a photograph taken from an accurate cast of the original by Mr. F. C. Wills.

Reduced—26 : 10.



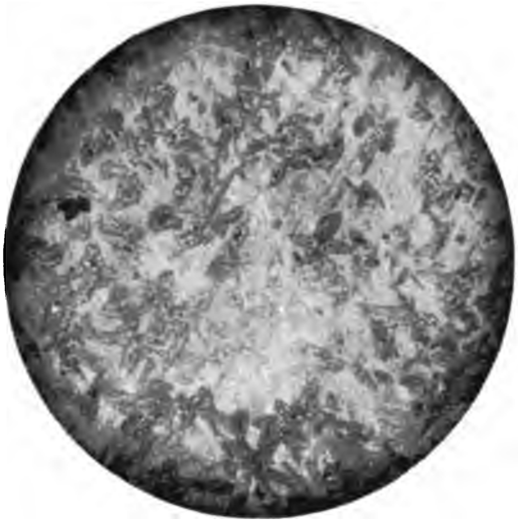
Scale of centimetres.

Heliotype.

PLATE VIII.

Fig. 1. Cowra iron : etched figures, highly magnified.
Fig. 2. Ditto : natural size.
Fig. 3. Bingera iron : etched figures, natural size.
Fig. 4. Ditto : highly magnified.
Fig. 5. Temora iron : etched figures, highly magnified.
Fig. 6. Ditto : natural size.

Reproduced by the Photo-engraving Company, Sydney, from negatives prepared by Mr. F. C. Wills.



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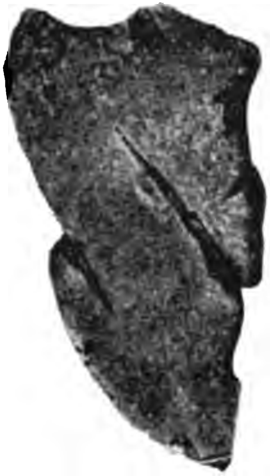

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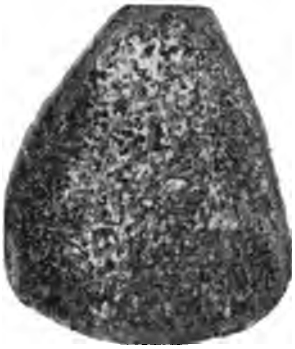

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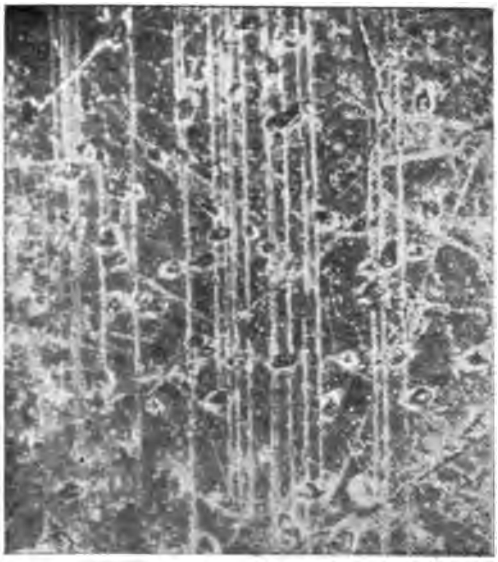

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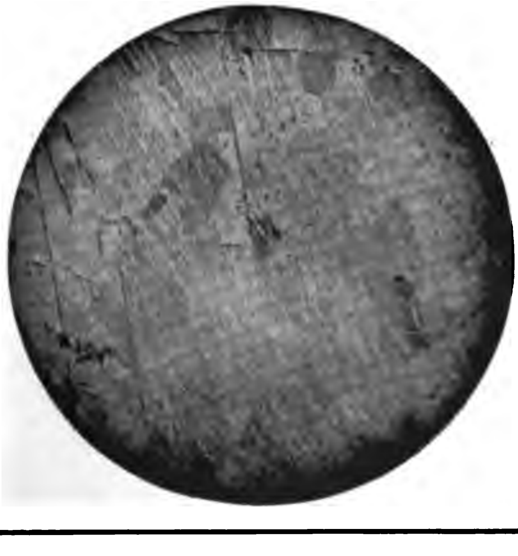

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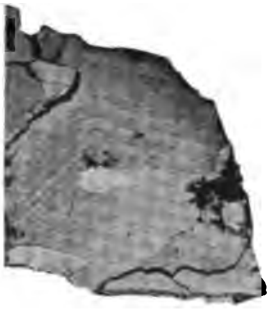


6

PLATE IX.

Glossopteris rectinervis, *Dun.*

Fig. 1. Imperfect frond, from the Ward River.

Fig. 2. Portion of Fig. 1, enlarged to show the venation. x 2.

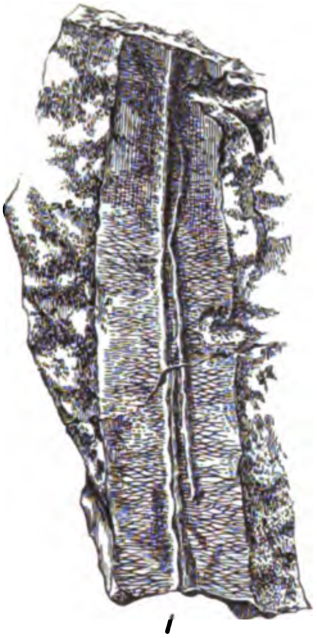
Fig. 3. Another leaf, showing a somewhat similar venation.

Glossopteris acuta, *Dun.*

Fig. 4. Portion of a frond, from Cremorne Bore, No. 1.

Fig. 5. Do do x 2.

Drawn from nature by Mr. F. R. Leggatt.



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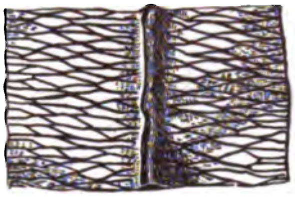

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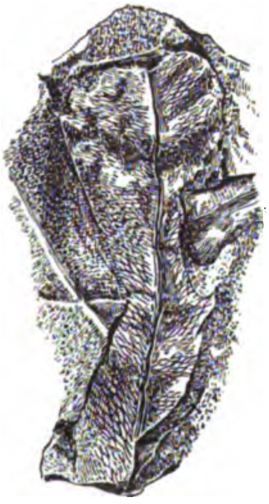

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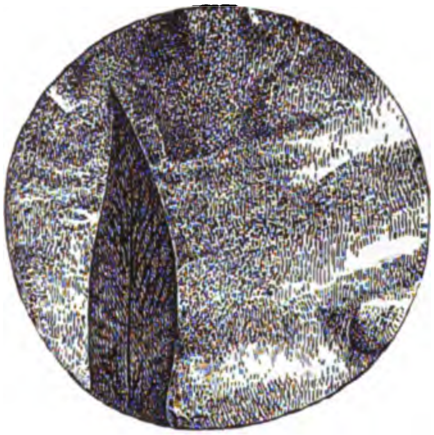

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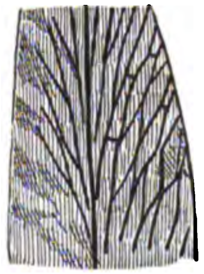

5

Frank R. Leggat, del.

Heliotype.

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Map showing Mineral Areas of New South Wales. Scale, 16 miles to 1 inch.
Do do do Scale, 50 miles to 1 inch.
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Do do do do Scale, 22 miles to 1 inch.
Do do do prepared under the direction of E. F. Pittman, &c., &c., Gover Geologist. Scale, 16 miles to 1 inch.
Geological Map of the Districts of Hartley, Bowenfells, Wallerawang, and Rydal, by C. S. Wilkinson, L.S., F.G.S.
Geological Map of Hill End and Tambaroora, by E. F. Pittman, Geological Surveyor.
Geological Map of the Vegetable Creek Tin-mining District, by T. W. E. David, B.A., F.G.S., Geological Surveyor 58 chains to 1 inch.
Index Map of the Vegetable Creek Tin-fields, by T. W. E. David, B.A., F.G.S. Scale, 80 chains to 1 inch.
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Diagrams showing the Thickness, Character, and Portion mined out of Coal-seams in the Coal Measures of New Wales, by John Mackenzie, F.G.S., Examiner of Coal-fields.
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Geological Sketch Map showing boundary of the Cretaceo-Tertiary Formation in the County of Cowper, by W Anderson, Geological Surveyor, 1889.
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Geological Map showing the principal Stanniferous Leads in the Tingha and Elsmore Districts, by the late Wilkinson, F.G.S., F.L.S., and T. W. E. David, B.A., F.G.S., 1895.

(2.) PUBLICATIONS.

The Mining Act of 1881, with Regulations.
Annual Reports from 1875 to 1893 inclusive.
Mines and Mineral Statistics, 1875. [Out of print.]
MINERAL PRODUCTS OF NEW SOUTH WALES, 1882, containing:—
1. Mineral Products of New South Wales, by Harrie Wood, J.P., Under Secretary for Mines.
2. Notes on the Geology of New South Wales, by C. S. Wilkinson, L.S., F.G.S., Geological Surveyor-in-Charge
3. Description of the Minerals of New South Wales, by Archibald Liversidge, M.A., F.R.S., F.C.S., F.G.S., Professor of Chemistry and Mineralogy in the University of Sydney.
4. Catalogue of Works, Papers, Reports, and Maps on the Geology, Palæontology, Mineralogy, &c., &c., Australian Continent and Tasmania, by Robert Etheridge, Junr., of the British Museum, and Robert Logan F.R.G.S., F.G.S., Government Geologist for Queensland.

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5. Geology of the Broken Hill Lode and Barrier Ranges Mineral Field, New South Wales, by J. B. Jaquet, &c. (4to. Sydney, 1894.)

Palæontology.

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RECORDS

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VOL. V, PART III.

1897.

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RECORDS

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GEOLOGICAL SURVEY OF NEW SOUTH WALES.

Vol. V.] September, 1897. [Part 3.

XVII.—Geological Notes upon a Trip to Mount Kosciusko, New South Wales: by J. B. Jaquet, A.R.S.M., F.G.S., Geological Surveyor.[*]

THE route taken was from Jinderbayne *via* Wilson's Valley, Piper's Creek Diggings, and Thompson's Flat to the summit of Mount Townsend. From thence a descent was made into the head of the Crackenback Valley, and Jinderbayne reached by way of the Thredbo Diggings. The country traversed has been geologically reported upon by two previous observers.[†][‡]

The dominant country rock is granite, which, under dynamo-metamorphic influences, has been changed in places into gneiss. It seemed to me that the gneissoid character became more pronounced as the summit of the range was approached.

The foliation planes of the gneiss run approximately N.E. and S.W. and parallel with the main ridge.

Upon the eastern end of Boggy Plains, at the head of Wilson's Valley, I found dykes of a basic augite andesite intruding the granite. I had a microscopic section prepared from a specimen of this rock which I collected. It consisted essentially of porphyritic crystals of augite, olivine, and rarely felspar, imbedded in a microcrystalline base.

---

[*] The greater portion of this paper was embodied in my Report to the Government Geologist dated 9th June, 1895. [Ann. Rept. Dept. Mines and Agric. N. S. Wales for 1896 [1897], p. 183.] The Rev. J. Milne has also contributed some notes on the geology of this district to the Linnean Society of N. S. Wales. [Procs., 1897, XXI, Pt. 4, p. 819.]

[†] R. von Lendenfeld. Report on the results of his recent examination of the central part of the Australian Alps. (Folio, Sydney, 1885. By authority.) Petermann's Mittheilungen, 1887, Ergärzungsheft, Nr. 87.

[‡] R. Helms, Procs. Linn. Soc. N. S. Wales, 1893, VIII, p. 349.

Near the summit of Kosciusko micaceous slates and schists are to be found. These rocks possess a perfect cleavage with planes which are approximately parallel with the foliation planes of the gneiss. They have been much crumpled and contorted, and in places have undergone a process of silicification. These characteristics can be particularly well observed in the gap between the highest peak upon the Kosciusko Plateau and the Ram's Head Range. Here they include lenticular quartz veins of a character similar to those which yield gold elsewhere in the Colony. I knocked off a piece of the quartz and had it assayed upon my return to Sydney, but it yielded neither gold nor silver. A gold reef is now being worked at Grey Mare's Bogong, about seventeen miles north of Kosciusko, in this same belt of rocks, and, in my opinion, the circumstances warrant a careful prospecting of the country between these two places being undertaken.

The question as to whether evidences of a former glaciation are to be seen upon the Snowy Mountains has long exercised the minds of geologists. Dr. R. von Lendenfeld, who examined the country in January, 1885, answers this query most emphatically in the affirmative.* He states that he found "rocks polished by glacial action in several places," and illustrated his report with a photograph of one of such rocks. Mr. Richard Helms, in a paper communicated by Prof. T. W. E. David to the Linnean Society of New South Wales, states that he searched carefully in the Wilkinson Valley and elsewhere for striæ and polished surfaces without finding them, though, he adds, the general appearance of the rocks at a distance suggested that they had been ground down by glaciers. Mr. Helms also records having found one piece of what he believes to be glacier-polished rock. In speaking of this specimen, he says, "there are, however, no striæ noticeable, which is rather remarkable, as they are generally present upon glacier-polished surfaces."

I did not see any polished surfaces or grooved rocks which might reasonably be supposed to have been produced by moving ice. Upon Thompson's Flat (Tom's Flat) I was able to identify, by means of the photograph which accompanies Dr. von Lendenfeld's report, the granite rock which he specially mentions as exhibiting glacier-polish. The smooth surface of this rock might well be the result of ordinary denudation. At the base of the mountains, and elsewhere in the Colony where granitic formations occur, similar smooth surfaces are to be found. The grooves are in section more or less V-shaped. They consist of ordinary planes of parting which have been enlarged by weathering along their lines of emergence. A penknife blade can in many instances be inserted into the cracks below the grooves.

I agree with Mr. Helms when he says that the rocks forming the range would disintegrate too rapidly to permit of glacier-striæ being retained upon their surfaces for any length of time.

---

* *Op cit.*

Mr. Helms states that he found several terminal moraines, and he has also prepared a map showing the localities where he believes glacial deposits exist.

At Piper's Creek, which is situated at an altitude of five thousand six hundred feet, and is distant from Mount Kosciusko about eleven miles, gold has been found in shallow drift deposits consisting of black loam with subangular pebbles of granite and quartz. The gold occurs in patches and not defined "runs." During several months of the year the field cannot be approached with safety on account of the snow; and the rigorous climate and the long distance over which supplies have to be brought will always be against its advancement.

Thredbo Diggings are situated upon the Crackenback River, about twelve miles from Jinderbayne. The field at one time supported a large number of miners, but there are now only one or two "fossickers" upon it. The gold occurs in patches under a wide alluvial flat.

It was pointed out to me that a considerable amount of the gold occurred in the superficial and weathered portions of the granite, and I have had the same statement made to me in reference to auriferous drifts at Major's Creek, near Braidwood, which also rest upon granite. The waterworn character of the gold grains at both localities contradicts such a statement, and is undoubted evidence that the precious metal had been derived from elsewhere. Granite, owing to the facility with which its component felspars undergo kaolinisation, will, under favourable circumstances, rapidly disintegrate, and it would in many instances be impossible to distinguish between a bed of decomposed and collapsed granite boulders and a layer of the same rock which has weathered *in situ.* During my examination of the older gold-bearing gravels, etc., in the Shoalhaven Valley, I not infrequently found beds of disintegrated granite interstratified with beds of sand and gravel, and all the circumstances would seem to point to these beds having been formed as described above. To a miner this subject may be of great importance, since he might be liable in some instances to mistake a "false bottom" of decayed granite for the true bottom or bed-rock.

Since the date when this paper was written, the Author has again crossed the mountains in the vicinity of the Big Bogong Peak, about twenty miles north of Kosciusko, and found further intrusives of a basic character.

Between the head of Snowy Plain and the gap in the lower range which fronts the Big Brassy Mountain, dykes of a rather interesting dacite are to be seen intruding gneissoid granite. The rock has a specific gravity of 2·70. When freshly fractured it has a dark grey colour, and white quartz grains of considerable size, and small, glistening, black hornblende crystals can be distinguished by the naked eye. In thin sections under the microscope it is seen to consist of porphyritic crystals of hornblende and corroded quartz grains, imbedded in a micro-crystalline base composed of a more or less felted aggregation of hornblende microlites and triclinic felspars. Some of the hornblende crystals exhibit a most beautiful zoning. (Slide 993, Geol. Sur. Coll.) An all-defined fluxion structure can sometimes be observed around the quartz grains. It may be that the intrusive rock has absorbed a portion of the granite, and that the quartz grains had their origin in this manner.

Upon the top of the range, about four miles south of the Big Bogong Peak, I found other intrusions of andesite. A microscopic examination of a section prepared from one of these rocks showed it to be very similar in character to the one last described. It, however, contains much less quartz. The porphyritic hornblendes are frequently twinned, some of them have been slightly crushed, and one crystal was found to be faulted. (Slide No. 994.) It would seem, therefore, that the andesites were intruded prior to the occurrence of the earth movements which produced the gneiss.

About half a mile south of the Grey Mare's Bogong Peak, and not far from the junction between the sedimentary rocks and granite a boss of amphibolite occurs. A microscopic examination showed it to consist of massive hornblende grains, with green and yellow coloured interstitial matter. Under the microscope the cementing material was seen to be composed of secondary quartz, which included partially decomposed fragments of hornblende and numerous minute and nearly colourless rods. The latter, one felt at first sight inclined to describe as acicular crystals of indeterminate or at any rate disputable character, similar to those which are so often found enclosed in quartz and other minerals. A closer investigation, however, shows them to consist for the most part of fine rods of hornblende which have become detached from the larger grains of this mineral. The rock was probably at one time composed solely of interlocking hornblende grains, and these have been replaced in part with quartz. The silica would seem to have crept into the rock between its component grains, and then afterwards to have grown forward, replacing the hornblende molecule by molecule. Minute plates or rods of hornblende resisted the attack of the acid solutions and, replacement proceeding beyond them, became detached and imbedded in the quartz. In many instances one can see such rods projecting, and in the act, as it were, of being floated off the original grains. (Slide No. 995.) A minority of the inclusions possess hexagonal and other definite crystalline forms, and could not have originated in the manner described above.

Near the entrance to the tunnel, which has been started upon the eastern slope of the Grey Mare's Bogong for the purpose of cutting the auriferous quartz-reef, doleritic dykes intrude the granite. When microscopically examined the dolerite is seen to be much crushed and otherwise altered. It consists essentially of augite and lath-shaped triclinic felspars with green alteration products. An ophitic structure can be observed in places.

In the Geological Survey Collection I found a diorite which had been collected from the top of the Big Bogong Peak. It is composed of brown hornblende, triclinic felspar, and hyperathene (?).

I also found a quartz-hypersthene-diorite from Kiandra, a small mining township, near the summit of the range, about twenty miles north of the Bogong. (Slide 807.) The minerals represented are quartz, felspar, and hypersthene. The latter exhibits straight extinction and the characteristic pleochroism; and the majority of the grains have partially undergone a paramorphic change, and are fringed with green hornblende. My colleague, Mr. G. W. Card, Curator and Mineralogist, has described a very interesting norite from Wyalong, which is largely composed of grains of hypersthene undergoing a similar transformation.

XVIII.—On the Occurrence of Devonian Plant-bearing beds on the Genoa River, County of Auckland: by W. S. DUN, Assistant Palæontologist.

[Plates X and XI.]

TOWARDS the end of last year Mr. J. E. Carne, Geological Surveyor, forwarded for determinations some imperfect specimens of ferns collected by him in the Parish of Genoa, County of Auckland. These specimens, unfortunately, are not only fragmentary, but show very little of the structure. Still, as our knowledge of the Devonian Flora of Australia is so small, it has been thought advisable that some notes on this occurrence should be prepared. Mr. Carne describes the general geology of this district in a preliminary report. He says—"From the coast to the Howe Range the formations consist of Devonian sandstones, conglomerates, and clay shales. At the Range about three hundred feet of conglomerates overlies the granite which forms the base of the elevated ridge stretching northerly from Mallacoota Lake to Twofold Bay. From the Howe Range to about one and a half miles west of the Eden-Genoa Road at Timbilica, the formations consist of slates, sandstones, and schists, with occasional intrusions of porphyry; from the intermediate position of these beds between the overlying Devonian and the more cleavable slates, and sandstones, and schists of the Monaro Tableland further west they may be provisionally classed as Upper Silurian, though continuous search has failed to discover palæontological evidence to definitely establish their proper geological horizon. West of the Timbilica Road granite occurs, being the southern extension of the Wyndham, Wolumla, and Bega outcrops. Stretching westerly into the Parish of Yambula it remains the surface rock. Frequent diorite intrusions were noted but usually quite barren of quartz at the junctions. A narrow belt of Upper Silurian slates and sandstones stretches northerly from the Border across Mount Waalimma. West from this belt the granite is overlaid in the Yambula and Nungatta Ranges by massive beds of sandstone, conglomerates, and grey and ferruginous clay shales, reaching a thickness at some points of over 1,200 feet. These beds are practically horizontal or gently dipping. From the shale bands the party were successful in securing sufficient palæontological evidence . . . . to determine on reasonable grounds the true age of this series which I believe is identical with the beds of similar character in the Eden-Pambula District.[*]

From the Upper Devonian Beds of Iguana Creek, on the Mitchell River, in Gippsland, Sir Frederick M'Coy has described[†] *Archæopteris Howitti*, M'Coy, *Sphenopteris iguanensis*, M'Coy, and *Cordaites australis*, M'Coy, and, in my opinion, the first and last of these occur in the Genoa River Beds, which it is logical to assume to be of the same age. A very full account of these Iguana Creek beds will be found in Mr. A. W. Howitt's "Notes on the Devonian Rocks of North Gippsland."[‡] Mr. R. A. F. Murray also deals with them at considerable length in his "Geology and Physical Geography of Victoria."[§] At this place the plant beds consist of a band of grey-green shale in sandstone, and these beds with a very low angle of dip overlay almost vertical Middle Devonian at Tabberaberah. The series in the type district, Iguana Creek, is composed of conglomerates, sandstone, grits, shale, and thick reddish shales. It is probable that the Genoa River beds are synchronous with the Upper Devonian Beds of Iguana Creek, but this will be dealt with in detail by Mr. Carne in his final report.

II.—Descriptions.

Pecopteris, *Brongniart*, 1822.

(Mem. Mus. Hist. Nat., Paris, VIII, p. 33.

Pecopteris (?) obscura, sp. nov.

(Pl. X, figs. 1, 2; Pl. XI, figs., 6, 8.)

Under his name I venture to class the fern represented in Pl. x, figs. 1, 2, and Pl. xi, figs. 6, 8. It must clearly be understood that *Pecopteris* is used in a very wide and indefinite sense, as nothing is known of the venation or fructification. As will be seen by the figures, this fern was of a robust habit, with strong stem. Bipinnate and possibly tripinnate, pinnæ alternate, as a rule about one and a quarter inches long, and one inch apart. The pinnæ appear to be opposite, close, small, attached by the whole of their bases and not petiolate; entire, apex incurved and acutely pointed. The only trace of the venation that is preserved is the indistinct impression on several pinnules of a midrib extending to the apex; nothing is known of the secondary venation, assuming that there was one, so that only a very unsatisfactory comparison of the genera can be made. According to Schimper's sub-division of fossil ferns into four larger families according to the venation:—Neuropterideæ, Adiantidæ, Sphenopterideæ, and Pecopterideæ, as summarised by Lesquereux,[*] the only one in which our Genoa fern can find a resting-place is the last. The Pecopterideæ comprise ferns with fronds simple, pinnate or bi-tri-pinnate, pinnæ alternate, pinnules adhering by base, sometimes confluent and lobed, entire or denticulate, primary and secondary venation, dichotomous. This large sub-division takes in ferns from the Devonian to the Cretaceous. Schimper, in Zittel's Palæophytologie, classifies sterile fronds under thirteen heads, Sphenopterideæ, Palæopterideæ, Neuropterideæ, Cardiopterideæ, Odontopterideæ, Alethopterideæ, Pecopterideæ, Pachypterideæ, Lomatopterideæ, Phlebopterideæ, Tæniopterideæ, Glossopterideæ, Dictyopterideæ, by means of venation and shape of pinnules. Of these, the only ones in which our fossil could fit, are the Odontopterideæ and Pecopterideæ, in the first-named the venation springing from the rachis and is furcate. On the whole there seems to be slightly more negative evidence in favour of its being classed as *Pecopteris.*

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[*] Ann. Rept. Dept. Mines and Agric. N. S. Wales for 1896 [1897], p. 101.
[†] Prod. Pal. Vict., 1876, Dec. 6, pp. 21-23, t. 36.
[‡] Geol Survey, Vict., Prog. Rept., III, 1876, pp. 181-249.
[§] 8vo. Melbourne, 1887, pp. 60-65.

After searching through all the literature at my disposal I can find nothing to which this species can be compared, certainly it is not like any of the typical Pecopterids that have been figured.

Sphenopteris, *Brongniart*, 1822.

(Mem. Mus. Hist. Nat., Paris, VIII, 33.)

Sphenopteris Carnei, *sp. nov.*

(Pl. X, fig. 3; Pl. XI, figs. 3, 4, 5.)

The specimens figured prove the occurrence in these beds of an undoubted Sphenopterid fern of a Lower Carboniferous type. Some of the pinnules are entire, ovate, of the form of the recent *Adiantum*, resembling somewhat those of *Sphenopteris adiantoides*, Lindley.[†] In other cases the pinnules are incised, sometimes deeply, and approach in that respect to *Sphenopteris Hœninghausi*, Brongniart,[‡] as figured by Andræ,[§] and Potonié,[||] but our fern differs much from this last in point of its greater size and different habit. The pinnules do not appear to be lobed but deeply incised, and in some cases this condition appears to be of a secondary nature, splitting. From the figures it will be seen that the pinnules vary very greatly in form, presenting an ovate entire outline, a more elongate shape, lobed and also of a deeply incised form. The very great range in pinnule form admissible in similar ferns will be seen in Potonié's paper on *Sphenopteris Hœninghausi* already quoted.

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[*] 2nd Geol. Survey Penn., Description of Coal Flora, 1880, I. pp. 71-72.

[†] Foss. Flor. Gt. Britain, III, t. 115.

[‡] Hist. Veg. Fossiles, p. 199 t. 52.

[§] Vorweltliche Pflanzen, 1866, p. 13, t. 4, 5.

[||] Jahrb. K. Preuss. Geol. Landesanstalt for 1890 [1892], XI, p. 16, t 7 and 8.

This form is bi-tri-pinnate, rachis slender, pinnæ opposite, pinnules petiolate, alternate, adiantiform, entire, or incised, venation simple furcate. In the literature at my disposal I can find records of no Sphenopterids closely approaching to this form and the comparison with *S. Hœninghausi* is mainly one of dissimilarity. There is no resemblance between it and any of the hitherto described Australian Sphenopterids.

Genus.—ARCHÆOPTERIS, *Dawson*, 1863.

(Canadian Naturalist, VIII, p. .)
(Fide S. A. Miller, Am. Pal. Foss., 1877, p. 22.)
(Pl. XI, Figs. 1–3.)

Archæopteris Howitti, M'Coy.

Archæopteris Howitti, M'Coy, Smyth's Progress Report Geol. Survey Vict., 1875, II, p. 73.
" " *Ibid.*, 1876, III, p. 62.
" " Couchman's Progress Report, Geol. Survey Vict., 1877, pp. 155–156.
" " Prod. Pal. Vict., 1876, Dec. 4, p. 21, t. 36, f. 1–2a.
" " R. Etheridge, junr., Catalogue of Australian Fossils, 1878, p. 209.
" " Feistmantel, Palæontographica, 1879, Suppl. Bd. III, Lief. 3, Heft 2, p. 142.
" " Feistmantel, Mem. Geol. Survey New South Wales, 1890, No. 3, p. 96.
" " Tenison Woods, 1883, VIII, Pt. 1, p. 96.
" " Feistmantel, Sitz. K. Bohm. Gesell. Wissen., Math.-Naturw. Cl., 1888, p. 627.

The portion of a pinna figured in Pl. XI, figs. 1–3, appears without doubt to belong to *Archæopteris Howitti*, M'Coy from the Devonian olive shales of Iguana Creek, Victoria. The agreement with M'Coy's figures is very close (with the exception that our specimen is smaller than the Victorian), and, also with the American species of the same genus, indeed it is hard to say whether this form should not be listed as one of them—the resemblance to the form described by Dawson as *Palæopteris Rogersi*,* being very noticeable. Sir Frederick M'Coy compares this specimen more particularly with *Archæopteris Jacksoni*, Dawson,† first described as a *Cyclopteris*, but from a comparison between his figures, Sir William Dawson's, and the specimen herein mentioned it appears to me that there is a closer approach of *A. Howitti*, M'Coy to *A. Rogersi*, than to *A. Jacksoni*, though the difference between all three is very slight, mainly that of size. From *A. hibernica*, Forbes, from the Devonian of Ireland there is a well marked difference in size, and relative position and form of the pinnules.

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* Quart. Journ. Geol. Soc., 1863, XIX, p. 463, t. 17, f. 17, 18; t. 19, f. 27.
† *Ibid.*, XVIII, 1862, p. 319; XIX, 1863, p. 462, t. 19, f. 26.

Genus.—CORDAITES, *Unger*, 1850.
(Gen. et Spec. Plant., 2nd ed., p. 50.)
Cordaites australis, M'Coy.
(Pl. XI, Fig. 8.)

Cordaites australis, M'Coy, Smyth's Progress Rept. Geol. Survey Vict., 1875, II, p. 73.
" " Couchman's Ibid., 1877, IV, pp. 155, 156.
" " Prod. Pal. Vict., 1876, Dec. 4, p. 22, t. 36, f. 6, 7.
" " Etheridge, R., junr., Cat. Austr. Fossils, 1878, p. 80.
" " Feistmantel, Palæontographica, 1879, Suppl. Bd., III, Lief. 3, Heft 2, p. 142.
" " Feistmantel, Mem. Geol. Survey New South Wales, 1890, Pal. 3, p. 151.
" " Tenison Woods, Procs. Linn. Soc. New South Wales, 1883, VIII, Pt. 1, p. 155.
" " R. Etheridge, junr., Geol. and Pal. Queensland, 1892, p. 198.
" " Feistmantel, Sitz. K. Bohm. Gesell. Wissen., Math.-Naturw. Cl., 1888, p. 638.

To M'Coy's species *Cordaites australis*, the specimen figured in Pl. XI, Fig. 8, may be referred. Nothing more can be said of it than that it agrees with the original description, the clasping base is shown and the longitudinal markings are clearly shown, but the breadth is greater than in the original figures of *C. australis.* Sir Frederick says that it is common in the Devonian Beds of Iguana Creek, and the late Rev. Tenison Woods is of opinion that it occurred in Queensland, at Gympie and Drummond Ranges. Mr. R. Etheridge states in the above-mentioned work that he did not see specimens of it in the collections of Queensland fossils he worked over.

XIX.—Mineralogical and Petrological Notes, No. 6: by GEORGE W. CARD, A.R.S.M., F.G.S., Curator and Mineralogist.

1. The Mungindi Meteorite.
2. Cupro-scheelite from Yeoval.
3. Stolzite from Broken Hill.
4. Andesite from Myall, Tomingley.
5. Igneous Rocks met with at a depth in Artesian Bores.
6. Volcanic Glass from near Copeland.
7. Volcanic Ash from near Eden.

1. *The Mungindi Meteorite:*—This is an iron meteorite comprising two pieces weighing sixty-two and fifty-one pounds respectively. They are described as having been found, early in this year (1897), by a half-breed. They were lying

together, covered by the red soil, three miles north-north-east from the Mungindi Post Office, New South Wales, and therefore belong to Queensland territory. Several small pieces were detached, and two of these were sent to the Mines Department for identification. The meteorites were subsequently secured for the Mining and Geological Museum by Mr. E. C. Whittell, Field Assistant. The meteorite would appear to have lain for some time, as it is considerably weathered, so much so as to give rise in places to naturally-etched Widmanstätten Figures.

2. *Cupro-scheelite from Yeoval*:—This mineral has recently been detected at Taylor's copper mine, Upper Timby, close to Yeoval. The ore consists of bornite with copper carbonates, and the cupro-scheelite is closely associated with it. It is waxy in appearance and, while sometimes white, is generally of a greenish tint. In places rectangular outlines can be seen. Cupro-scheelite is known to occur at Peelwood, where it is intimately associated with scheelite and stolzite. An analysis of a sample picked from the material most nearly free from colour gave results as follows:—

Moisture and combined water	2·55
Tungstic trioxide	57·73 (66·7)
Lime	14·40
Magnesia	0·22
Ferric oxide	2·98
Alumina	trace
Copper oxide	7·08 (8·18)
Molybdic oxide	trace
Carbonic oxide	1·56
Gangue	13·04
	99·56

Neglecting the gangue, and recalculating the percentages of copper and tungstic trioxide become respectively 8·18 and 66·7. The percentage of tungstic trioxide is rather low, but there is not enough carbonic acid to account for the copper; moreover reactions for copper were invariably obtained with colourless fragments.

3. *Stolzite from Broken Hill*:—This mineral has been obtained in several different forms from the open cut at the Proprietary Mine.

(*a*) Flattened, leaden-gray, tetragonal pyramids with little or no prism.

(*b*) Leaden-gray tetragonal prisms with low pyramids.

(*c*) Claret-coloured pyramidal forms—perhaps hemihedral.

In all these the crystals are very small.

(*d*) Colourless or white crystals with adamantine lustre; very tabular in habit. These are of considerable size, the specimen in the Mining Museum having a length of side of more than a centimetre.

4. *Andesite from Myall, Tomingley*:—This is the country rock of the Myall reefs. The base is ferruginous and opaque, with numerous minute crystals of felspar scattered through it. In places devitrification patches of clear mosaic occur. Plagioclase, in phenocrysts, is seen in places altering into epidote, while more frequently the alteration is complete, the place of the felspar being taken by rounded patches of epidote and quartz. A distinct tendency to fissility is noticeable in the rock.

5. *Igneous Rocks met with at a depth in Artesian Bores*:—The following have recently come under notice:—

(*a*) Woolabra Bore, depth 1,779 feet. A fine-grained olivine-basalt. The olivine occurs as serpentine pseudomorphs, which are numerous. The base consists of very finely granular augite with minute lath-shaped felspars. Other felspars, of small size, are embedded in the base.

Woolabra Bore, depth 1,917 feet. Also basalt but not so fine-grained as the above. Augite is plentiful. Olivine comparatively fresh.

(*b*) Trangie Bore, depth 552 to 610 feet. A much-altered, dark greenish andesite. Opaque felspar, showing twin striation to the naked eye, is abundant. The felspar phenocrysts are much clouded by development of kaolin. Zoning by inclusion, and addition of felspar—material by secondary growth—are sometimes to be seen. Scattered through the base are numerous smaller lath-shaped felspars. Here and there are patches of undecomposed augite, (?) but the place of the ferro-magnesian silicate appears to be taken by isotropic green alteration products.

(*c*) Dargle Bore, depth 1,018 feet. A fine-grained rock, under the microscope seen to be much clouded by decomposition. Altered phenocrysts of felspar are embedded in a matrix consisting of numerous lath-shaped crystals, and aggregated groups of the same mineral, with numerous minute patches of quartz—apparently of secondary origin.

6. *Volcanic Glass from near Copeland*:—A beautifully perlitic glass of a brown colour, somewhat resembling common opal, and containing phenocrysts of very fresh orthoclase, showing perfect crystallographic outlines where not corroded by the matrix or penetrated by glass inclusions. Numerous simple crystallites are scattered through the base.

7. *Volcanic Ash from Eden.*

XX.—The Occurrence of Lower Silurian Graptolites in New South Wales: by W. S. Dun, Assistant Palæontologist.

In November, 1896, Mr. J. E. Carne forwarded to the Department a collection of graptolite bearing shales from the Parish of Lawson, County of Wellesley. An examination of these specimens showed that they were undoubtedly Lower Silurian forms, and indicated beyond doubt the extension of the Victorian Lower Silurian Beds over the Border. This is a fact that has been reasonably expected for some time, and this, the first detailed examination of the districts along the Border, has added evidence of another formation occurring in New South Wales.

On the geological map of New South Wales this country is shown as of Upper Silurian Age, while immediately over the Border in Victoria Lower Silurian beds are mapped, and Mr. R. A. F. Murray mentions[*] "the discovery in the slates at Deddick, near the New South Wales boundary line, of a graptolite (*Diplograpsus rectangularis*, M'Coy), and the identification at Guttamurrh Creek, Snowy River, of *Didymograpsus caduceus* and *Diplograpsus foliaceus* in vertical slates capping the granite." The Rev. W. B. Clarke describes the general geology and features of these southern districts in various reports, but makes no allusion to Lower Silurian rocks;[†] while in the latest edition of his "Sedimentary Formations" he says, "of the graptolitidæ, only one is said to have been found in the Colony, and I presume that it is more likely to belong to the Upper Silurian than to the Lower, though towards the Victorian boundary, along the Deleget River, Lower Silurian rocks, according to some, are supposed to make their appearance."[‡] Mr. C. S. Wilkinson, in his "Notes on the Geology of New South Wales," makes mention[§] of altered sandstones and slates in the Murrumbidgee district, and near Moruya, "greatly resembling in lithological character the Lower Silurian bed of Victoria; but hitherto no fossils have been found in them." This statement is repeated in the second edition of this work.

In Victoria Lower Silurian rocks are largely developed, and in some localities—Bendigo, Lancefield, and Castlemaine—graptolites are abundant. These forms have been described by Sir Frederick M'Coy, and Messrs. Etheridge, T. S. Hall, and Pritchard, and a list of the principal papers on the subject is appended. Sir Frederick classed these beds as Lower Silurian, and correlated them with the Welsh Llandeilo. Professors Marr[*] and Nicholson[†] speak of them as Arenig, *i.e.*, older than Llandeilo. They may also be correlated with the rocks of the Calciferous (Quebec) group of North America, many species of graptolites being common to the two formations. From the general resemblance of the New South Wales forms it is safe to approximately correlate the beds with the slates of North-eastern Victoria recently described by Mr. T. S. Hall.

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[*] Geol. and Phys. Geogr. Victoria, 1887, p. 42.

[†] On the auriferous character of the country along the Bendoo and Deleget Rivers (Report XIII). Papers relative to Geol. Surveys. New South Wales, 1852, No 7, pp. 22-25 (Fcap. Sydney, 1852. By Authority). Parl. Blue Book, Feby. 28, 1853, p. 72 (Fcap. London, 1853. By Authority). Southern Goldfields, p. 200 (8vo. Sydney, 1860).

[‡] Sed. Form., 4th ed., 1878, p. 12.

[§] Mineral Products of New South Wales, 1882, p. 39; 2nd edition, 1887, p. 53.

Mr. A. R. C. Selwyn, late Director of the Geological Survey of Victoria, and then of Canada, says, speaking of Victorian Lower Palæozoic rocks, "east of the Snowy River, near Delegete, where the more slaty structure, characteristic of the lower beds, commences again, the double graptolites appear as the only fossil."[‡]

Mr. Carne briefly describes the geology of the Parish of Lawson in his Progress Report for the year 1896.[§] He says:—"The Devonian Beds extend west along the Border to the junction of the Bondi River and Hopping Joe Creek, in the Parish of Bondi, County of Auckland. From thence to the main coast range in the same parish granite extends to near the brow of the tableland; here a narrow belt of slate and schist is separated from the main mass by a narrow intrusive offshoot of granite, which forms the eastern escarpment of the Manaro tableland on the Border. From this point to the Irondoon Range, just west of the Little River, slates, sandstones, and schists occur. At the Irondoon a narrow intrusion of gneissic granite occurs, but pinches out a short distance north of the Border. The sedimentary formations of the tableland fortunately afforded an interesting suite of graptolites."......This is the first definite determination of Lower Silurian rocks in the colony, which, however, was anticipated upon the occasion of the first geological examination of the district, opposite which in Victoria this formation had been identified." It appears, from the contained species of Graptolites, that these beds are higher in the series than those occurring at Castlemaine and Bendigo.

In a recent paper, Mr. A. E. Kitson remarks that owing "to the great inclination and lithological characteristics of the rocks" at Gehi Wall, Mt. Kosciusko, he considers them to be Ordovician. No fossils were found.[‖]

In February, 1897, Mr. Carne made further collections of graptolites from three other localities in the County of Wellesley:—(1) The south-west corner of Parish of Currowang; (2) Stockyard Creek, Parish of Alexander; and (3) from one and a half miles south of Portion 2, Parish of Tingaringi.

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[*] Science Progress, 1896, V, p. 368.

[†] Manual of Pal., 1889, I, p. 222.

[‡] Intercolonial Exhib. Essays, 1866–67 [186], p. 12.

[§] Ann. Rept. Dept. Mines and Agric., New South Wales, for 1896 [1897], p. 101.

[‖] Proc. R. Soc. Vict., 1897, IX, (N.S.) p. 24.

The graptolites from the Parish of Lawson are imperfectly preserved as shiny films on a black slate, and in most cases little or nothing can be made out of their structure or specific relations. Generally speaking the species are small in size, and may be considered as dwarfed specimens of the characteristic Victorian species.

Dicranograptus furcatus, Hall.
" ?
Dicellograptus, sp. ind.
Didymograptus cf. caduceus, Salter. (?)
Diplograptus, cf. mucronatus, Hall.
" cf. rectangularis.
Phyllograptus. (?)

The form listed as *Dicranograptus furcatus*, Hall, is, I think, without doubt the same as that figured by McCoy* under the name of *Cladograpsus furcatus*, Hall sp. Dr. Gurley† states that Geinitz' genus *Cladograpsus* was not properly defined, and therefore should be dropped.

The forms referred to *Didymograptus caduceus*, Salter (?), are both small and of somewhat slender proportions.

The species of *Diplograptus* are the most common in this lot.

The *Phyllograptus*, perhaps a stunted form of *P. typus*, Hall, is uncommon.

The specimens from the south-west corner of the Parish of Currowang, County of Wellesley, are imperfectly preserved in a whitish, coarse-grained slate, stained with iron. They comprise—

Diplograptus cf. palmeus, Barrande.
Dicranograptus, sp.
Dicellograptus.

From Stockyard Creek, Parish of Alexander, County of Wellesley, preserved in a black granular slate. These forms are slightly better preserved—

Dicranograptus furcatus, Hall.
Diplograptus cf. palmeus, Barrande.
Diplograptus, sp., (? rectangularis, McCoy.)
Dicellograptus, sp.
" extensus, Hall.

From this locality some portions of the structure of *Diplograptus*, sp. Barrande, are exceedingly well developed and preserved; several specimens show the virgula, vadicle, and lateral spines very clearly and of considerable length. No signs of the projections of the hydrothecæ remain, and it is possible that this form may close to *D. rectangularis*, McCoy or even *Climacograptus*.

From a locality one and a half miles south of Portion 2, Parish of Tingaringi, County of Wellesley we have—

Diplograptus, cf. palmeus, Barrande.
Didymograptus, sp.
Dicranograptus furcatus, Hall.
Dicellograptus, sp.

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* Pal. Prod. Vic., Dec. II, p. 34, t. 20, f. 7.
† Journ. Geology, 1896, IV, Pt. 1, p. 93.

From a comparison of these lists, it will be seen that *Dicellograptus*, *Diplograptus* and *Dicranograptus* are the commonest genera. A doubtful *Phyllograptus* occurs at Parish Lawson only. It is unfortunate that the state of preservation of these delicate organisms is so unsatisfactory, and it is possible that further collections may throw more light on the species preserved. Still it seems to be beyond all doubt that these beds denote an extension into New South Wales of the Victorian Lower Silurian Series, and we may hope soon to find the relation between the slates and the Upper Silurian beds so well developed a little to the north of this.

A list of papers on the Victorian Graptolites is appended for the information of readers:—

List of Papers relating to Australian Graptolites.

ETHERIDGE (R., Junr.):—

Observations on a few Graptolites from the Lower Silurian Rocks of Victoria. *Ann. Mag. Nat. Hist.*, 1874, XIV (4), pp. 1–10, t. 3.

A Catalogue of Australian Fossils. Pp. 4–10. (8vo., Cambridge, 1878.)

HALL (T. S.):—

On a New Species of Dictyonema. *Procs. R. Soc. Vict.*, 1892, IV (n.s.), pp. 7–8, t. 1, 2.

The Geology of Castlemaine; with a subdivision of part of the Lower Silurian Rocks of Victoria, and a list of minerals. *Procs. R. Soc. Vict.*, 1895, VII (n.s.), pp. 55–88, t. 6.

The Distribution of the Graptolitidæ in the Rocks of Castlemaine. *Rept. Austr. Assoc. Adv. Sci.*, 1894, V, pp. 374–375.

Notes on *Didymograptus caduceus*, Salter, with Remarks on its Synonymy. *Procs. R. Soc. Vict.*, 1896, VIII (n.s.), pp. 69–73.

On the Occurrence of Graptolites in North-eastern Victoria. *Procs. R. Soc. Vict.*, 1897, IX (n.s.), pp. 183–186.

HOPKINSON (J.) and LAPWORTH (C.)—Descriptions of the Graptolites of the Arenig and Llandeilo Rocks of St. Davids. *Quart. Journ. Geol. Soc.*, 1875, XXXI, pp. 631–672, t. 33–37.

M'COY (F. Kt.):—

Prodromus of the Palæontology of Victoria, 1874, Dec. I, pp. 5–20, t. 1, 2; *ibid.*, 1875, Dec. II, pp. 29–37, t. 20; *ibid.*, 1877, Dec. V, 1877, t. 39–41, t. 50.

On a New Victorian Graptolite. *Ann. Mag. Nat. Hist.*, 1876, XVIII (4), p. 126.

PRITCHARD (G. B.):—

On a New Species of Graptolitidæ. *Procs. R. Soc. Vict.*, 1892, IV (n.s.), pp. 56–58, t. 6.

Notes on some Lancefield Graptolites. *Procs. R. Soc. Vict.*, 1895, VII (n.s.), pp. 27–30.

XXI.—The Diatomaceous Earth Deposits of New South Wales: by G. W. CARD, A.R.S.M., F.G.S., Curator and Mineralogist; and W. S. DUN, Assistant Palæontologist.

[Plates XII-XV.]

I.—General Character of Diatomaceous Earth.

THE Diatomaceæ or Bacillariæ are microscopical confervoid Algæ, living in both salt and fresh water. The plants consist of either a single diatom or frustule (*Navicula, &c.*), or else of an aggregate of the frustules forming filamentous strings (*Melosisa, Diatoma*). This frustule consists of a cell enclosed in a siliceous carapace consisting mainly of the two valves and the zone, cingulum, or girdle consisting of the overlapping portion of the valves. In the scope of this paper we are concerned only with the general form presented by the siliceous hollow structure formed by the valves. It is formed of colloidal silica secreted by the organism, and the shape is extremely variable, the ornamentation being arranged longitudinally, radially, transversely, in lines, dots, or pits, and may be alveolate (coarse dots), striate (fine lines formed by minute punctures), costate, or moniliform. All diatoms possess a raphe or median cleft or line with central and terminal nodules, according to Van Heurck, though in some cases these are very obscure. On this character the main subdivision of the Diatomaceæ into Raphidiæ, Pseudoraphideæ, and Cryptoraphideæ is based.

As before remarked, diatoms inhabit fresh and salt water, and some forms even live in damp soil. Their distribution is exceedingly wide, from the Tropics to the Arctic and Antarctic Regions, and on lofty ranges of mountains. The marine forms differ generically as a rule and invariably specifically from the fresh water, but there is a certain mingling, as might be expected, in brackish water, which also has its characteristic species. The geological range is also great, from the Carboniferous to the present time, though deposits are not of frequent occurrence till the Tertiary is reached. According to Dr. Van Heurck[*] the oldest deposit occurs in the London Clay (Lower Eocene), and is described by Mr. W. H. Shrubsole.[†] Numerous forms were found here, and were pyritised and encrusted with pyrites. Schimper mentions Diatoms in Upper Cretaceous Beds,[‡] while[§] in a footnote he draws attention to Castracane's discovery of existing species in the English Coal Measures. I have been unable to refer to the original paper,[||] but in his paper in the Comptes rendus* he states that Diatoms have been found in the Carboniferous at Liverpool, Newcastle, St. Etienne, and in the Scotch Cannel. Schimper quotes the following species as being found by Count Castracane—*Fragilaria Harrisoni* (Sm.), *Epithemia Gibba* (Ehr.), *Sphenella glacialis* (Ktz.,) *Gomphonema capitatum* (Ehr.), *Nitzschia curvula* (Ktz.), *Synedra vitrea* (Ktz.), *Diatoma onlgare* (Bory.) This list serves to show what little variation there has been in these minute organisms during the course of time.

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[*] Treatise on the Diatomaceæ, p. 43. (4to. London, 1896.)
[†] Journ. R. Micros. Soc., 1881, , p. 381.
[‡] Tillet's Handb. de Pal., Abtheil. II, p. 14.
[§] *Loc. cit.*, p. 14.
[||] Jahrb. Wiss. Bot., 1874, x; Atti Accad. Pontif. Nuovo Lincei, xxvii, 1874.

The abundance of these organisms under favourable conditions may be gathered from the fact that "A deposit of mud no less than four hundred miles long by one hundred and twenty miles broad was found at a depth of between two hundred and four hundred feet, on the flanks of Victoria Land in 70° south lat."† This deposit is composed of Diatom ooze, its thickness is unknown. In the Antarctic Regions the sea is often thick with Diatomaceæ, which also tinge it and the ice a dull yellow. Instances are also on record of shallow estuarine harbours being choked by their rapid accumulation. Ehrenberg has estimated that one cubic inch of Diatomaceous Earth, contains about forty-one billion frustules.

II.—Physical Properties.

The existence of deposits of Diatomaceous earth in New South Wales has long been known and, from time to time, the possibility of utilising these, more especially in the manufacture of dynamite, has been considered. Many new uses are now being found for the material, and the subject has locally aroused considerable interest, suggesting the advisability of bringing together the information now available.

Diatomaceous earth is a siliceous material, generally more or less white in colour and frequently pulverulent in nature, found in very many places widely distributed over the globe. It is known under a variety of names, more or less appropriate. Of these "infusorial earth" was at one time very generally used, but its inaccuracy has led to its becoming less common: it is still frequently met with however. The objection to its use is that true Infusoria do not enter into its composition at all. The German name, "kieselguhr," having reference to its siliceous nature is generally used commercially. Another equally common term is "tripolite" derived from Tripoli, in North Africa, where extensive deposits occur. It is advisable perhaps to avoid confusion by dropping this term to a certain extent, as it is applied in America to various siliceous earths differing entirely in constitution from true infusorial earth, more particularly to a material now mined in large quantities in Missouri, and referred to more particularly below. A pure diatomaceous earth would consist of silica and water only. The silica is in the colloidal condition, and the water exists partly combined and partly as absorbed moisture. For purposes of comparison it is perhaps advisable to calculate percentages after neglecting the moisture which is a variable quantity depending upon external circumstances such as time of exposure. This ideal composition is seldom met with, varying proportions of carbonates of lime and magnesia, clay, &c., being generally present. The percentage of silica is generally between eighty and ninety. Occasionally organic matter is present in sufficient quantity to colour the earth, and also to maintain combustion for calcination purposes after having once been ignited. This is the case with some of the German earths. The presence of iron is frequently revealed by the red or yellow colour of the calcined material. In some cases too, as will be again pointed out, the percentage of silica is increased by its extraneous introduction. Consisting as it does of silica, diatomaceous earth is not affected either by extreme heat or by acids, but being in the colloidal form is readily acted upon by alkaline solutions. The characteristic physical property of tripolite is its extreme lightness, the specific gravity being less than one quarter that of water. With low density is correlated excessive porosity, both being determined by the structure of the individual organisms composing it. As these organisms will be fully described below, it will now suffice to remark that, consisting as they do of very delicate siliceous membranes enclosing a space, it follows that the earth comprises a vast number of air cavities capable of being occupied by any liquid absorbed. In this way an average sample of diatomaceous earth will absorb from four to five times its own mass of liquid. When saturated the density increases to about 1·24, and the rock will sink in water. It is to these three properties of low density, porosity, and resistance to heat and acids that tripolite owes what value it may possess. The earth was known to the Greeks and Romans, Strabo writing about building stones of such lightness that they float upon water, and the Emperor Justinian instructed his architects to use it in building the dome of Hagia Sophia. After calcination the specific gravity is increased by about fifty per cent.

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* Comptes rendus Acad. Sci. Paris, 1874, lxxix, p. 52.

† Myers, Introd. Study Diatomes, p. 2. (8vo. London, 1893.)

ANALYSES of Diatomaceous Earths from Foreign Localities.

	Germany.	Germany.	Hanover.	Hanover.	Hanover.	Hanover.	Hanover (Hermannsberg).	Bilin.	Bilin.	Laugschiefer.	Oberohe.	Scotland.	Scotland (Aberdeen).	Tuscany (Santa Flora).	Auvergne (Ceyssat).	Nevada (Little Trucker River).	Nevada (Storey County).	Maryland (Pope's Creek).	New Jersey (Morris County).	Virginia (Richmond).	Mauritius.	Australasia (loc. ?)	Canada (New Brunswick, Pollett Lake).
Silica	8·01	92·08	86·4	91·3	80·9	79·8	84·15	87·58	74·20	80·30	96·85	92·0	95·34	79·0	87·2	91·43	81·08	81·53	80·06	75·86	72·0	87·40	*80·457
	82·97	**98·90**	**95·01**	**97·33**	**92·14**	**95·23**	**94·44**	**95·12**	**91·24**	**92·75**	**100·00**	**97·35**	**96·31**	**83·76**	**97·71**	**95·57**	**100·00**	**84·45**	**94·80**	**83·74**	**92·20**	**99·26**	**94·45**
Ferric oxide	6·82	0·23	1·5	1·0	1·8	2·6	0·70	2·04	6·81	5·40	trace	2·50	3·65	3·0	....	3·62	....	3·33	....	2·92	2·5	0·65	0·951
Alumina	7·13	0·79	1·6 (clay)	1·0 (clay)	3·5 (clay)	1·9 (clay)	1·40				trace			5·0	2·0			3·43	3·84	9·88	2·5	....	3·146
Lime	....	....	1·3	0·2	1·6	0·3	1·75	1·09	0·41	0·44	....	....	....	....	....	0·25	....	2·61	0·58	0·29	....	....	0·342
Magnesia............	....	....	....	0·3	....	0·4	1·10 (carbonate)	0·30	....	0·43	....	....	....	....	....	0·36	....	5·63 (with K_2O, Na_2O, &c.)	....	1·63 (with K_2O, Na_2O, &c.	....	....	0·233
Water	8·45	5·21	6·9	6·2	8·3	15·0	10·40	8·89	13·30	10·90	3·15	5·50	0·03	12·0	10·0	3·80	18·44	3·47	14·01	8·37	21·0	8·22	13 332
Other volatile matter	8·17	1·04	2·3		3·9		....	....	4·20	1·30	...		0·32	....	....	....		....		....	....	2·15	
	98·58	99·35	100·00	100·00	100·00	100·00	90·50	99·90	98·92	98·77	100·00	100·00	99·34	99·00	99·20	99·46	99·52	100·00	99·09	98·95	98·00	98·42	98·54

* 92 per cent. of the air-dried material was soluble in caustic potash.

The silica percentages printed in black type have been calculated after neglecting all water and volatile matter.

ANALYSES of Diatomaceous Earths from New South Wales.

	Barraba, 3 miles from.	Barraba.	Barraba.	Glen Innes, 32 miles from.	Richmond River, Wyrallah.	Richmond River, Wyrallah.	Cooma.	Cooma.	Cooma.	Warrumbungle Mountains.	Warrumbungle Mountains.	Queensland, Pine Creek.
Silica	71·62 **80·66**	71·13 **81·54**	80·56	71·53 **81·85**	86·01 **96·81**	90·94 **96·25**	81·64 **91·83**	83·30 **94·28**	80·94 **90·79**	82·62 **93·07**	72·94 **81·68**	89·10 **99·34**
Ferric oxide		0·91	1·77	trace		0·49 ferrous oxide.	0·40	0·36	1·23		0·87	
	14·07				2·83	0·33				5·20		0·59
Alumina		13·06	4·15	14·36		2·38	3·20	3·84	4·61		4·57	
Calcium carbonate	1·43	0·31 (lime)	0·31	0·82	trace	......	1·50	0·30 (lime)	0·86	0·95	9·53	trace
Magnesia carbonate	1·66	0·87 (magnesia)	0·21	0·68	trace	trace	2·16	0·36 (magnesia)	0·45	trace	0·70 (magnesia) 0·69	......
Sodium chloride	......	Carbon dioxide. 0·95	......	......	......	0·32	......	0·25	1·06	....	... .	......
Combined water	4·03	5·67	12·84	6·14	5·96	2·79	3·77	5·84	2·99	3·49	3·08	10·31 (with organic matter.)
Moisture at 100° C................	7·30 (with organic matter.)	7·33		6·50	5·36	2·69	7·18	5·40	8·07	7·70 (at 105° C.)	7·88	
	100·11	100·23	......	100·03	100·16	99·94	99·85	99·65	100·21	99·96	100·26	100·00

The silica percentages printed in black type have been calculated after neglecting all water and volatile matter.

Notes on the Analyses.—Comparing the silica proportions it will be noticed that the highest in New South Wales is that given by the Wyrallah earth. It must be remembered, however, that a portion of this silica appears to have been deposited from solution, binding the whole into a compact mass and not in any way adding to its absorbent properties. The extreme purity of some of the foreign earths, more particularly those from Oberohe and Storey County, Nevada, will be noticed. Magnesia and lime vary much in quantity, reaching ten per cent. in one of the Warrumbungle samples. Whereas some of the German earths contain a very high percentage of organic matter, sufficient, in fact, to effect their calcination, New South Wales earths contain but little volatile matter other than water. The analyses have been conducted upon samples in very varying conditions of dryness; to permit of ready comparison on a uniform basis the silica percentage has been recalculated in each case after neglecting all volatile matter. In the case of such wet earths as that from Mauritius and one of the Bilin samples the silica content is thus made much more prominent.

IV.—Economic Characters, &c.

Uses and Properties.—The combination of valuable physical properties possessed by diatomaceous earth has led to its utilization in a variety of ways. Its application in the Arts will be dealt with under the heading of the property to which its value is due.

Abrasion.—This is due to the hardness, sharpness, and minute size of the individual particles of which diatomaceous earth consists. When levigated it constitutes an admirable polishing powder. In the case of very finely pulverulent earths like the Victorian little or no preparation is needed: indeed, polishing powders consisting of the earth either crude or but slightly prepared have been placed on the market in Australia and Canada under various brands. By mixing the pulverised material with the usual ingredients a valuable soap has been manufactured.

Absorbency.—This property is due to the structure of the individual micro-organisms. Consisting as they do of an external skeleton partially enclosing a space, it follows that a piece of Diatomaceous earth contains an innumerable number of cavities (as before-mentioned a cubic inch contains some forty-one billion diatoms). On immersion in liquid the air is displaced from these cavities and the liquid absorbed. In this way diatomaceous earth can absorb, on an average, from four to five times its own mass of water. This property has been taken advantage of in a number of ways, more particularly in the manufacture of explosives. It was formerly largely used in the manufacture of dynamite, where it served as an absorbent for the nitro-glycerine. It is now, however, being replaced by wood-pulp and other cheaper substances. The German earth is said to be better fitted for this purpose than the American. We hear that in a recent Report of the United States War Department the Victorian tripolite was said to be the very best in the market for this purpose. In a variety of minor ways this property has been made use of, such as for carrying disinfectants in hospitals. The firm of G. W. Reye and Sons, Frankenstrasse 28, Hamburg, has introduced a series of useful articles.

Solubility.—Although quite unaffected by acids, the silica of diatomaceous earth, being in the colloidal condition, is readily dissolved by alkaline solutions with the formation of a silicate of the alkali. In the case of the Pollett Lake Earth Hoffman found that 92 per cent. of the air dried material was soluble in boiling caustic potash. In the form of soluble silicate of soda or water-glass it has been used as a cement for building stones, &c. In general, however, clean white sand would probably be found cheaper.

Low Specific Gravity.—Very early attention was drawn to tripolite by its low density. A cubic yard of tripolite fire-bricks was found to weigh twelve hundredweights, only one-fourth the weight of the same volume of Dinas bricks. The Emperor Justinian (522 A.D.) directed his architects to make use of such bricks in building the dome of the Hagia Sophia at Constantinople. In rough country the advantage of bricks of such lightness, where carriage is difficult and costly, is evident.

Non-Conductivity to Heat.—It is to its ultimate composition again that diatomaceous earth owes its remarkable properties as a non-conductor of heat. In passing from one medium to another heat suffers a certain amount of loss by reflection and refraction. In consequence of the innumerable air cavities the heat waves have to pass repeatedly from silica to air, from air to silica, and suffer a corresponding loss in energy; their intensity is thus very quickly reduced in traversing a small thickness of tripolite. A brick may be held in the hand at one end while the other is being strongly heated. It is to this property that it owes somewhat extensive use for boiler and steam-pipe covering. In this sphere of usefulness the competition of asbestos packing has to be met; scrap mica is also being now used for this purpose. It is, or has been, used by the P. and O., Orient, Inman, and White Star Lines. The American earths have been found more suited for this than they are for the manufacture of explosives. It has been suggested that tripolite would be found equally resistant to electricity, and could thus be used for the insulation of telegraph and other wires.

Infusibility.—Consisting as it does of practically pure silica, tripolite is an admirable refractory material; at ordinary temperatures it is indeed quite infusible. From time to time attempts have been made to use it in the manufacture of fire-bricks, with what success it is rather difficult to ascertain. In the "Mineral Resources of the United States"* reference is made to "Kieselguhr fire-brick" manufactured by a North London Company. Their lightness is said to render them specially suited for blast furnace pipes, covering retorts, for special purposes in chemical works where non-conducting properties are desirable, and for retort settings in gas-works. The specific gravity of a manufactured brick is given as 0·6. Their success is said to be undoubtedly established. Some inquiries made in London by the Authors with a view to obtaining the address of this Company were not successful. The average analysis of the earth from which these bricks were made is given as follows:—

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* Mineral Resources of the United States, 1893, p. 607.

Silica	83·8
Magnesia	0·7
Lime	0·8
Alumina	1·0
Ferric oxide	2·1
Organic matter	4·5
Moisture and loss	7.1
	100·00

Some experiments made by Hoffman with the earth from Pollett River Lake, New Brunswick, are of interest.* Five test bricks were made having the following proportions:—

1. Diatomaceous earth alone.
2. Do 95 parts, white pipe-clay 5 parts.
3. Do 90 do do 10 do
4. Do 99 do lime 1 do
5. Do 98 do do 2 do

The earth and clay were air-dried, and the lime freshly prepared. The bricks were moulded in a small hand-press, air-dried, and finally dried at 100° C. They were then placed in covered crucibles and heated in an air furnace, the temperature being gradually raised for an hour, and then maintained at a white heat for two hours. All five were found to have perfectly retained their form, and their edges were perfectly sharp. All were highly absorbent, firm, and tough. Nos. 1, 2, and 3 had very smooth surfaces and a fine close texture; they decrepitated strongly when suddenly plunged into the flame of a blast lamp. Nos. 4 and 5 were looser in texture and stood well. All were excellent non-conductors. The contraction was greatest in Nos. 2 and 3—11·18 %, and least in 5—7·89 %. Nos. 4 and 5 were quite white, while 1, 2, and 3 were uniformly creamy in colour. Hoffman notes that this is in accordance with the fact that the alkaline earths, especially lime and magnesia, have a singular power of bleaching ferruginous clays in the kiln, so low a proportion as 5 % of caustic magnesia mixed with a red clay entirely destroys its red colour. In weight No. 3 was heaviest, and 4 lightest. Several attempts have been made in New South Wales to manufacture Kieselguhr fire-bricks. At the Bulli Tile Works bricks were made with a mixture of tripolite and the local fire-clays. After having been built into the furnaces for about three months, however, the bricks were found to shrink to an enormous extent, and their manufacture has been given up.

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* Prog. Rept. Geol. Survey, Canada. Montreal, 1879-80, p. 3 H.

Miscellaneous Uses.—Attempts have been made to utilise tripolite in packing fruit for export, with what results the Authors are unaware. Locally it has been used in the manufacture of refrigerating paint, but as no attempt has been made to place it on the market no comparison can be made with other similar preparations. It is found of service in packing acids for transport. The United Kieselguhr Company at Chelle also utilise the German earth for ice manufactories, rendering floors, walls, and ceilings fire and rot proof, as a filling for ice-chests, fire-proof safes, strong-rooms, &c. It is sold either pure or as composition (mixed with asbestos or hair).

Value and Production.—Very little has as yet been done with the New South Wales deposits. At Cooma a small quantity has been raised for experimental purposes, and 676 bushels of Richmond River tripolite were shipped from Grafton for trial during 1896. In the latter case a price of 3s. 6d. per bushel was obtained, but out of this all expenses had to be met. The Victorian (Lilicur Creek) earth is of such a remarkably fine quality that it is able to command a high price; accurate statistics are not available. In America the price appears to vary from about twenty to fifty shillings per ton of two thousand pounds. The production in the United States in 1894 was 2,584 short tons. At the Bass River, Nova Scotia, some 400 tons, said to be worth about £4 a ton, were raised during 1895. In Nevada mining is not prosecuted regularly, enough being obtained in one year to meet the demand for some time. It is difficult, however, to get accurate statistics, as tripolite is generally included with other substances in returns.

In conclusion, it would appear as if the deposits of diatomaceous earth in New South Wales cannot compare in quantity with those of America and elsewhere. In quality there is perhaps little to choose, but they cannot compare with the very fine Victorian earth. The Barraba, Warrumbungle Mountains, and perhaps some others, are too far from rail for profitable working. Cooma and Wyrallah are conveniently situated in this respect, the former being near the railway, the latter being accessible to water carriage. There is as yet no great demand for Diatomaceous earth, and should the demand arise, the quantity available in almost every part of the world is practically inexhaustible.

V.—Foreign Occurrences.

The records of foreign occurrences of Diatomaceous earths are so numerous that only a few of the more importent or more interesting are mentioned in this paper.

A laminated fissile variety known as "polirschifer" occurs in numerous European and South American localities, notably near Bilin, Bohemia. Here it is described as occurring above gneiss and a gypseous clay and protected by a capping of phonolite. At Lausitz it occurs above and below brown coal, and is covered by basaltic tuffs and lavas. Between Kasan and Saratov on the Volga the beds of polishing slate are said to attain a thickness of forty feet.

Leaf and fish remains, or even beetles, are sometimes found in the earth, and its geological age when known is generally Tertiary or Post-tertiary. Tripolite proper only differs from polirschiefer in not possessing a fissile structure. It is generally of Tertiary age* and frequently occurs in peaty districts. There are very many deposits in Europe of which several are worked. That at Naterleuss in Hanover yields kieselguhr of the purest quality and lowest specific gravity. It there attains a thickness of 150 feet, and is covered by thin alluvial beds. The upper portion is white in colour and contains some sand. After washing it affords an excellent material. At a lower level there is less sand, but the presence of organic matter affects the colour. There is sufficient organic matter to effect calcination, and kieselguhr of the finest quality results. The lowest stratum is rendered green in colour by the presence of as much as 30 per cent. of organic matter. It is calcined in kilns, yielding a red kieselguhr, the colour being due to ferric oxide. The Hanover deposits are characterised by the presence of the forms *Synhedra ulna* and *Gaillonella (Melosira) aurichalcea.* On the north side of the Hochsimmer near Eltringen diatomaceous earth is associated with pumice and tuffs, the latter also containing diatoms.

At Franzenbad in Bohemia a deposit from six to eight feet thick occurs in a marshy district; the principal forms are *Navicula*, *Gomphomena*, and *Melosira.* At Altenschlirf and Steinfurth in the Vogelsberg the prominent forms are the fresh-water sponge *Spongilla* and *Melosira distans;* the thickness is from eighteen to twenty-four feet. Near Bauzten the earth has a yellowish colour and is granular in nature; *Fragillaria construens* is abundant. Berlin is partially built on a deposit of Diatomaceous earth. German kieselguhr has very high absorbent properties; the American is less absorbent. Very many deposits are known in America, some of extraordinary thickness, and a few of them have been worked. It has been noticed that the American beds are commonly found in swamps representing filled-up lakes of the glacial period. The most important producing district is Pope's Creek, Maryland. A large deposit has been recently discovered in Florida. At Richmond, Virginia, there is a well-known bed of diatomaceous earth extending across the State from north to south for more than a hundred miles. It is about thirty feet thick. The earth is yellow and clayey in appearance and is of Eocene age. At Monterey, California, it attains a thickness of fifty feet, and is also Tertiary. On an arm of the Upper Columbia River, Fremont discovered a deposit of porcellanous diatomaceous earth under a covering of basalt. It contained plant remains, and was no less than 500 feet thick. At Fossil Hill, Nevada, a thickness of 200 feet is attained. Numerous lake deposits of diatomaceous earth occur in various parts of Canada, more especially in Nova Scotia and New Brunswick. They are very numerous in the marshy districts of Nova Scotia.

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* The fact that Diatomaceous deposits are rarely older than the Tertiary epoch would not appear to have much significance. The ready destructibility of such incoherent rocks and their solubility in alkaline solutions facilitates their obliteration. If preserved at all in the older formations they should perhaps be looked for in compact chert beds comparable to the now well-known radiolarian cherts.

One of the largest occupies the bed and shores of Folly Lake, on the Intercolonial Railway. It is believed that these lakes could be readily drained. The material is being mined at Bass River, near Truro. Of the New Brunswick deposits, that at Pollett River Lake is perhaps the best known. Some important experiments conducted on the Pollett River earth have been referred to. In Chili a deposit composed of forms found living in neighbouring thermal springs occurs associated with pumice.

Recently the existence of diatomaceous earth has been noted at Lake Rudolf, East Africa.

A material occurring near Pontgibaud, and known as Randannite, must also be regarded as a diatomaceous earth.

Various siliceous substances have been incorrectly classed with infusorial earth, and a brief reference to some of these will be advisable. First among these is the Tripoli, extensively mined at Seneca, in south-west Missouri. This contains 98 per cent. of silica, and is believed to be either a siliceous limestone, from which the calcareous matter has been leached out, leaving a spongy mass, or a decomposition product from a clay.[*] It is very extensively used for filters, blotting pads, and as powder for polishing purposes. In Socorro County, New Mexico, there is a deposit also called Tripoli, containing about 80 per cent. of silica, occupying a depression in a volcanic country. It appears to have been formed of the débris of siliceous volcanic scoriæ.[†] It is not equal to tripolite as an abrasive. At Santa Fiora, in Tuscany, there is a white polishing slate consisting of irregularly formed little grains and chips of opal.[‡] Another so-called kieselguhr comes from Foissy, in Belgium. It is composed of globular little opal bodies which absorb pigments with great avidity.

In New Zealand deposits of diatomaceous earth are numerous, both of fresh-water and marine origin, the latter being the more important. These are classed as Pliocene mostly, though some are of more recent formation. The best known is that at Oamaru, which has yielded to the studies of Messrs. Grove & Sturt,[§] and Messrs. Hinde & Holmes,[||] a large number of species of Diatomaceæ and sponge spicules, and extends the range of several species occurring in the Barbadoes Deposits. This siliceous deposit also contains Radiolaria, and is considered to be of Eocene age. A general account of the geology of this deposit will be found in a paper by Mr. H. A. de Lautour.[¶]

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[*] Amer. Geologist, 1896, XVIII, No. 3, p. 136.

[†] *loc. cit.*, pp. 136–140.

[‡] There is, however, a true kieselguhr deposit an Santa Fiora.

[§] Journ. Quekett Micros. Soc., Ler. 2, II, III, 1886, 1887.

[||] Journ. Linn. Soc., 1892, XXIV, p. 177.

[¶] Trans. N.Z. Inst., 1828, XXI, pp. 293–311, pls, 18–23. Other papers on this subject are :—McKay (A.) On deposit of Diatomaceous earth at Pakaraka, Bay of Islands, Auckland. Trans. N.Z. Inst., 1890, XXIII, pp. 375–379. McKay (A.) On a diatom deposit near Pakaraka, Bay of Islands, Auckland. *Op. cit.*, XXV, 1892, pp. 375–377. Inglis (J.) Notes on some of the Diatomaceous deposits of New Zealand. *Op. cit.*, 1882, XV, pp. 340–346, t. 29. Spencer (W. T.) On the fresh-water algæ of New Zealand. *Op. cit.*, XIV, 1881, pp. 297–298. Inglis (J.) On new species of New Zealand diatoms. *Op. cit.*, XIV, 1881, p.p. 357–359, t. 22.

In South Australia we can find no record of true Diatomaceous earths. Mr. G. C. Morris[*] states that he found fresh-water diatoms in Coorongite, which he describes as a "Diatomaceous mineral," containing about 20 per cent. of hydrocarbons.

Regarding the Queensland occurrences, Mr. W. H. Rands says in his "Report on the Albert and Logan District,"[†] "Close to Pine Creek, near Selection 31, there is a hill called Meerschaum Mountain, from the fact that a very light white material somewhat resembling that mineral can be picked up on its sides. I have not seen this deposit *in situ*. This substance is an infusorial earth. Mr. W. H. Dixon of Sydney gives the following analysis of it:—

Moisture and traces of organic matter	10·31
Oxide of iron and traces of alumina	0·59
Lime	traces
Silica	89·10
	100·00

Mr. Dixon says that under the microscope the silica is almost entirely composed of the frustules of diatoms—probably *Melosira arenaria*. I confirmed Mr. Dixon's remarks as far as the microscopical examination went."

There seems to be a great resemblance between this earth and that occurring at the Richmond River, also locally known as "Meerschaum."

In Victoria the occurrence of Diatomaceous beds is fairly widespread, and they are of both Tertiary and Post Tertiary age, and of marine or estuarine and fresh water origin. Under the first heading the only deposit we need consider is that occurring near the Yarra, and representing an ancient extension of Port Phillip. From this bed Dr. Coates[‡] collected over forty species of Diatoms of the genera *Actinocyclus*, *Coscinodiscus*, *Campylodiscus*, *Stauroneis*, *Navicula*, *Orthosira*, *Pleurosigma*, *Epithemia*, *Synedra*, *Gomphonema*, *Surirella*, and others; as well as foraminifera and shells. As perhaps might be expected in a deposit of this nature the contents comprise species, fresh water, marine, and brackish in habit. Dr. Coates says that this mud dries into a grey coloured substance so friable that it is easily blown away. The part richest in foraminifera, &c., has the fewest diatoms.

This dried substance was mixed with ordinary clay and baked for bricks; but owing to the great contraction induced by heat, this was discontinued. A similar physical property is noted in another part of this paper, in the case of bricks made at Bulli.

In 1857 Mr. William Blandowski[§] described extensive deposits of diatomaceous earth in the Mallee Scrub, near Swan Hill, Lower Murray River, Victoria. He describes this as forming "an extensive belt of many miles in length by a width of from one quarter to one mile, and a depth of many feet; soft, and a little soapy to the touch." He figures some of these forms, but they are indeterminable from the drawings, with the exception of Fig. 6, p. 142, which, as he says, appears to be an *Eunotia*, comparable to *E. granulata*, Ehrenberg; fig. 3 may be the cross section of a sponge spicule. Some of these sketches (4 and 6) are of specimens from Albury.

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[*] Am. Nat., 1877, XI, No. 5, p. 377.

[†] Folio. Brisbane, 1889. By Authority. Geol. and Pal. Queensland, p. 330.

[‡] Procs. R. Soc. Vic., 1860, V, p. 158.

[§] On Extensive Infusoria Deposits in the Mallee Scrub, near Swan Hill, on the Lower Murray River, in Victoria, &c. Trans. Phil. Soc. Vict., 1858, pp. 141-146.

Blandowski gives no facts by means of which we can arrive at the age of these deposits, indeed they would appear to be practically recent, and to result from the drying up of extensive chains of shallow pools such as frequently occur in those districts.

Mr. F. M. Krause mentions the occurrence of hollows adjoining basalt being filled with layers of this earth in the Ballarat District.[*] The same Author gives a detailed account of the Lilicur deposits[†] and mentions its occurrence at Talbot, and at several places between Clunes and Eddington. The principal deposit in the Lilicur District is that occurring on Allotment 15, Section 1, Parish of Lilicur. The Diatomaceous earth completely fills a hollow in the basalt. It has an area of about four and a half acres, and a maximum thickness of seventeen and a half feet. The deposit has an almost horizontal stratification, and is very uniform in structure and appearance. He also draws attention to the resilicification of portions of the deposit and the formation of patches and bands of common opal. This has been observed in the Wyrallah and Cooma deposits in New South Wales. The specific gravity of the earth is 1·908, and of the common opal 2·008.

Patches of diatomaceous earth occur in a gully leading from the original deposit to Coralulup Creek, and in other places in the district. Two shafts were here sunk about three quarters of a mile from the main deposit, the second of which came across a bed of the earth eighteen inches thick beneath two layers of basalt. Mr. Krause states that the principal forms observed by him were *Pinnularia viridis*, *Navicula*, and *Synedra*, and considers the deposit to be of Upper Pliocene or Pleistocene, lacustrine origin. This is borne out by the additional forms examined by us.

Mr. J. E. Perry[‡] in an Australian earth (probably from Victoria), found *Navicula*, *Mastogloia*, *Pinnuluria*, *Cocconema*, *Surirella*. The specimens of *Mastogloia* were undergoing division. It is also recorded from Lancefield and Sebastopol as well as Amherst.[§]

Professor Kerner von Marilaun in his Natural History of Plants refers to a specimen of Australian Diatomaceous earth in the British Museum as containing a number of species. In reply to a request for information about this specimen,

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[*] Sch. Mines Ballarat, Ann. Rept., 1887, p. 89.

[†] Trans. R. Soc. Vic., 1887, XXIII, pp. 250–255, map.

[‡] Chemist and Druggist, 1895, XLVI, No. 779, p. 426, sketches.

[§] Descr. Catal. Rocks Vict. in Indus. and Tech. Mus. Melbourne, p. 127. (8vo. Melbourne, 1894.)

Dr. George Murray has kindly given us the following information:—"The block of Diatomaceous earth comes from a fresh-water deposit, Victoria, Australia. . . . . . . I find in the Catalogue of the Victorian Court, page 200, at bottom of page, "Infusorial earth, from Talbot, exhibited by Mr. Clarence Smith, Mining Surveyor." It is, *possibly*, our specimen (Dr. Murray had previously stated that he believed the specimen had been obtained by a dealer from the Colonial Exhibition). The species of diatoms found in it are—

Cymbella turgidula, *Grun.*
Stauroneis phœnicenteron, *Ehrb.*
Navicula major, *Kütz.*
　„ tenella, *Breb.*
　„ commutata, *Grun.*
　„ subcapitata, *Grey.*
Gomphonema dichotomum, *W. Sm.*
　„ subramosum, *Kütz.*
　„ subclavatum, *Grun, var.*
Achnanthes gibberula, *Grun.*
Cocconeis lineata, *Grun.*
Epithemia gibba, *var.* ventricosum, *Grun.*
Eunotia lunaris, *Grun.*
　„ arcus, *Ehrb.*, *var.* hybrida, *Grun.*
Synedra ulna, *var.* danica, *Kütz.*
　„ „ *var.* subæqualis, *Grun.*
　„ „ *var.* bicurvata, *Grun.*
　„ oxyrhynchus, *Kütz.*
　„ tenera, *W. Sm.*
Fragilaria virescens, *Ralfe.*
　„ „ *var.* exigua, *Grun.*"

In the collection of the Mining and Geological Museum there are Diatomaceous earths from Eglinton, Amherst, Belfast, Coralulup Creek, Splitter's Creek, Talbot, and Rodborough. Of most of these we can give no stratigraphical information, but there is a most marked resemblance between their contents. The more common forms are—*Diatoma, Cocconeis, Navicula, Melosira, Synedra, Eunotia, Tabellaria, Stauroneis, Epithemia, Cymbella, Achnanthes?, Eccyonema?, Suririella, Fragillaria.*

A species of *Diatoma* has been seen in the earths from Eglinton, Amherst, Belfast, Coralulup Creek, Splitter's Creek, and Rodborough. This appears to be *Diatoma vulgare*, Bory. Some of the forms seem to approach nearer to *D. anceps*, Ehrenberg, one of the species of *Diatoma* forming the subgenus *Odontidium*, The first-mentioned species forms a zigzag filament, and is finely costate, whereas the second form is composed of frustules, coarsely costate, and forming short filaments. The first-mentioned is much more common in the slides we have examined.

One species of *Cocconeis* occurs in all the earths examined. Of the species diagnosed by Dr. Van Heurck[*] the one to which our species bears most resemblance is *C. pediculus*, Ehrenberg, stated to be common everywhere in fresh or brackish water.

That very common form *Navicula* occurs also in all the deposits. In general form and structure it appears to approach nearest to *N. nobilis*, Ehr., in all except size, so that probably it is closely allied to the variety *gentilis*, of which Van Heurck says it may be considered to be a dwarf form.[†] There is another species of *Navicula* present, allied to *N. gastrum*, Ehren. In fact it is probable that several other species are present, but the variations are so great that we consider it better to name only the more common and well-marked forms.

In the earth from Eglinton and Talbot occur *Stauroneis*, allied to *S. phoenicenteron*, Ehrenberg, which is like a *Navicula* in outline and ornamentation, but possesses a well-marked stauros.

A small species of *Melosira* has been observed in the Eglinton, Amherst, Belfast, and Splitter's Creek earths. It appears to differ slightly from the New South Wales species, but chiefly in size. It will be referred to later on.

Synedra ulna occurs, in some cases abundantly, in all the earths, more especially at Coralulup Creek.

A *Eunotia*, allied to *Eunotia gracilis*, also occurs in all the earths examined by us.

Tabellaria, cf. *fenestrata*, Lyng., is fairly common at Belfast, Coralulup, and Splitter's Creeks, and we think we observed it in the Eglinton deposit.

Epithemia also occurs at Eglinton, Splitter's Creek, and Rodborough, and possibly at Belfast, at which *Fragillaria* is also very abundant.

Cymbella, the term which Van Heurck uses instead of *Cocconema*, occurs in all the Victorian, though only one specimen has been observed in the Talbot earth.

Doubtful specimens of *Gomphonema* were observed in the Coralulup and Amherst deposits. In the Rodborough earth *Eccyonema* cf. *prostratum*, Ralfs was seen. Forms allied to *Achnanthes* and also to *Campylodiscus* also occurred.

The *Spongilla* spicules closely resemble those occurring in the New South Wales earths, a description of which will be found later on.

NEW SOUTH WALES.

Cooma.—For the following description of these deposits we are indebted to the kindness of Warden John H. King. The deposit "is situated about five miles from Cooma and one and a half from Bunyan Platform. It occurs in a hollow partly surrounded by basalt hills. The surface is treeless and grassless, and the deposit is covered with about three inches of red earth and pieces of white quartz. The depth of the deposit is not known, as it has only been sunk on for sixteen feet. It is over a chain wide by six chains long exposed to view, and then occurs in the bottom of a gully about four feet deep. There is no doubt a large area of it, but deeply covered with soil." In this gully loose on the soil are pieces of red common opal. In thin sections under the microscope a translucent clouded field, dashed with black, red, and yellow blotches is seen, enclosing angular crystalline grains in places. By reflected light it is mainly red. With a ¼-inch objective the field is seen to contain comminuted fragments of diatoms, chiefly, if not altogether, frustules of *Melosira*, just as in the case of the diatomaceous earth itself. It is very evident that, as in the case of the Wyrallah deposits referred to later on, the common opal is caused by a deposit of colloidal silica cementing portions of the earth into a homogeneous siliceous mass. The deposit is a thick one, as proved by its being sunk upon to a depth of twenty feet, and then not bottomed. Three analyses of this earth have been made in the Departmental Laboratory. On reference to the tabulated results on page 132 it will be seen that the percentage of silica (moisture neglected) is remarkably uniform—a little over 88 per cent. Two of the analyses show the presence of appreciable quantities of iron, indeed the Cooma earth generally becomes yellow on calcination. The high percentage of carbonates of the alkaline earths in one of the analyses is noticeable. It would indeed seem as if these salts must have resulted from accidental impurities in the earth.

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[*] *Op. cit.*, p. 287.

[†] *Op. cit.*, p. 165.

This deposit appears to be of a greater extent and purity than any other as yet known in New South Wales.

Leaf impressions are said to occur here, but up to the present no opportunity has offered itself of obtaining specimens. The existence of black bands, bleaching on exposure, is said to have been noticed.

Microscopically the earth is composed almost entirely of *Melosira*, similar to those occurring in other New South Wales deposits, and well developed *Spongilla* spicules. These will be referred to later on.

Wyrallah.—The deposits on the Richmond River appear to be typically developed at Wyrallah, nine miles from Lismore. Here there seems to be a number of scattered deposits on either side of the Richmond River. They are surrounded and overlain by scoriaceous basalt, and occur in depressions in the same rock. Probably large areas of the Diatomaceous earth have been washed away. It has been stated at various times that considerable thicknesses of the earth exist on private lands, but this requires confirmation.

The physical character of the diatomaceous earth from these deposits is peculiar. It is hard and stony, requiring considerable pressure to crush it, and of a dirty white colour. The percentage of silica is high—over 90 per cent., and the lower portion of the deposit merges into a band of yellowish common opal, about a foot thick. Pieces of the opaline rock are marginally earthy, due probably to the removal by solution of the secondary silica, as in the case of chalk flints. The rock is isotropic, and marked with parallel bands, coloured by splashes of yellow and brown. With a high magnifying power the base is seen to be made up of hazy wisps and shreds, and numerous indistinct fragments of ***Melosira.*** This has been remarked on by the Rev. J. Milne Curran.[*] The opal is an intrinsic part of the deposit owing its compactness and homogeneity to the deposition of secondary silica. The percentage of substances other than silica is low. The high percentage of silica in diatomaceous earths is sometimes regarded as a point in their favour, but this must be accepted with great caution. In this case, and also in others, a proportion of silica is due in part to secondary silica, which would not only be of little use in itself for those purposes to which tripolite is put, but also renders the material hard and stony, necessitating crushing as above mentioned.

Granting the possibility of large quantities existing here, it is very doubtful whether this earth will ever receive much attention.

Fossil leaves are of frequent occurrence in this earth, known locally as meerschaum. The late Baron von Mueller has described, probably from this deposit, *Liversidgea oxyspora*, fronds of a species of *Pteris*, and portions of leaves, perhaps of *L. oxyspora.* [†]

Referring to a deposit from the Richmond River, described as "cimolite," by Professor Liversidge,[‡] Professor David says, "there can now be little doubt that this material . . . . . must graduate into a clayey diatomaceous earth, as diatoms in some numbers have been observed by me in a similar rock from the same locality."[†]

Warrumbungle Mountains.—This deposit has already been described by Professor David.[||] There are two out-crops at the bottom of the Wantialable Creek Gully. The bed of diatomaceous earth, three feet nine inches thick, occurs interstratified with a series of trachytic rocks. It is overlain by a remarkable series of trachytic tuff, and overlies another similar bed. A leaf referred to ***Cinnamomum Leichhardti***, Ett., was found in these tuffs. Professor David considers that they are of early Eocene or late Cretaceous age. As will be seen by the following section of the ridge, near the base of which the deposit occurs, we have first a trachyte sheet twenty feet thick, then trachyte tuffs of various conditions for about thirty-six feet, then the diatomaceous earth three feet nine inches, nineteen feet of tuffs, and then trachyte again. The tuff immediately above the earth contains numerous sanidine crystals.

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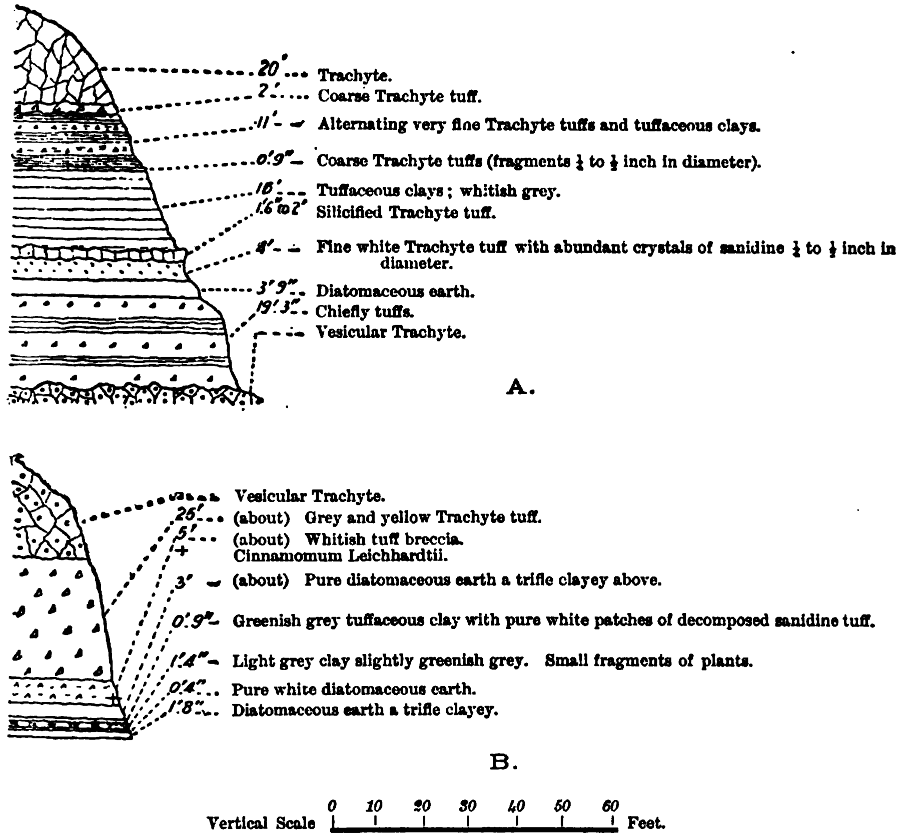
[*] Jour. R. Soc. N.S. Wales, 1897, XXX, p. 258.

[†] Jour. R. Soc. N.S. Wales for 1876 [1877], p. 240.

[‡] Journ. R. Soc. New South Wales for 1876 [1877], X, p. 239.

[§] Procs. Linn. Soc. N.S. Wales, 1896, XXI, p. 262.

[||] Procs. Linn. Soc. N.S. Wales, 1896, XXI, Pt. 2, pp. 261-261, t. 15-17.


20′ Trachyte.
2′ Coarse Trachyte tuff.
11′ Alternating very fine Trachyte tuffs and tuffaceous clays.
0′.9″ Coarse Trachyte tuffs (fragments ¼ to ½ inch in diameter).
16′ Tuffaceous clays; whitish grey.
1′.6″ to 2′ Silicified Trachyte tuff.
8′ Fine white Trachyte tuff with abundant crystals of sanidine ¼ to ½ inch in diameter.
3′ 9″ Diatomaceous earth.
19′.3″ Chiefly tuffs.
Vesicular Trachyte.
A.
Vesicular Trachyte.
25′ (about) Grey and yellow Trachyte tuff.
5′ (about) Whitish tuff breccia.
+ Cinnamomum Leichhardtii.
3′ (about) Pure diatomaceous earth a trifle clayey above.
0′.9″ Greenish grey tuffaceous clay with pure white patches of decomposed sanidine tuff.
1′.4″ Light grey clay slightly greenish grey. Small fragments of plants.
0′.4″ Pure white diatomaceous earth.
1′.8″ Diatomaceous earth a trifle clayey.
B.
0 10 20 30 40 50 60
Vertical Scale
Feet.

A. Section showing intercalation of Diatomaceous Earth in the trachyte series, Warrumbungle Mts.

B. Section showing association with *Cinnamomum Leichhardti*, Ett. These sections are, by kind permission of the Linnean Society of N. S. Wales, reproduced from Procs. Linn. Soc., N. S. Wales, 1896, xxi, pl. 16.

Some interesting notes on the general geology of the Warrumbungle Mountains will be found in an old report by Stutchbury.* It is possible he may have seen the diatomaceous deposits as he makes mention of a large portion of Keewang Swamp being "composed of a very light cream coloured deposit," and later on "a well sunk at Fisher's, in the valley of the Welleborowong Creek, exhibits the same light chalky clay as that at Keewang, also containing plants." He attributes the origin of these to decomposed trap rocks.

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* Papers relating to the discovery of gold, Parl. Papers, Feby., 1854, p. 9. (Fol., London, 1854.)

Referring to the remarkable and frequent association of diatomaceous earth with volcanic rocks, Professor David suggests that this is not fortuitous. "The superheated water flowing from hot springs and from the lavas themselves during the eruptions would be certain to carry more or less silica in solution, and its high temperature, combined with its dissolved silica, would probably render it a very favourable medium for the development of diatoms to the exclusion of most other kinds of plants."

Two analyses have been made by the Department (see table, p. 132). One of these showed the presence of no less than 10 per cent. of carbonate of lime. Iron and alumina are not exceptionally high, and silica reaches nearly 90 per cent. in the original analysis. There is some reason for thinking that some at least of the reported discoveries of tripolite in the Dubbo district are traceable to this deposit.

There would appear to be no probability of these deposits, as at present known, being of commercial importance.

Slides of this earth have been examined and are found to consist mainly of *Melosira* and *Spongilla* spicules; rare evidences of the occurrence of a naviculoid genus were also observed. Mr. Etheridge has reported* on this earth to some length, and little can be added to his remarks. He recognised as its constituents *Melosira*, cf. *orichalcea* and *Spongilla*. Further reference will be made to these forms.

Barraba.—This deposit has been described† by Mr. E. F. Pittman, Government Geologist. It occurs in the Nandewar Range, ten or twelve miles south-west of Barraba. Here the slates are overlain by basalt, forming a flat tableland. On this tableland there is, under the basalt, a large deposit of pure diatomaceous earth, attaining a thickness of at least eight feet, having a layer of coarse sand two inches thick about three feet from the top. It is probable that the entire series is forty or fifty feet thick, but this needs an exhaustive examination to prove it. It rests on a bed of sandy mudstone about a foot thick, under which is an impure deposit of diatomaceous earth containing rolled pebbles and fragments of interbedded lava. According to an analysis made by Mr. W. H. Dixon it contains 80·56 per cent. of silica, and has a specific gravity of 1·21; it is of a dead white colour, with black specks. More recently Mr. Pittman revisited the deposit and collected leaves of *Eucalyptus* and other plant remains from the associated beds. The bed above the earth is light coloured, and contains plant remains and also numerous sanidine crystals. These beds are apparently tuffaceous, fine grained, harsh to the touch, buff coloured, and to some extent calcareous. The floor of the deposit is also apparently tuffaceous, fine grained, and of a yellow brown colour. The series rests unconformably on or in a denuded hollow of the Gympie claystones, which Mr. Pittman found to contain, here, *Lepidodendron australe*, McCoy. Locally it is used as raddle.

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* Ann. Rept. Dept. Mines N. S. Wales for 1887 [1888], pp. 165–166; *Ibid.*, for 1888 [1889], p. 190.

† Ann. Rept. Dept. Mines N. S. Wales for 1881 [1882], p. 142.

Three analyses have been made by the Department. The highest percentage of silica is 80·56 (not allowing for moisture). All the analyses, two in particular, indicate the presence of much iron and alumina; the latter must exist as silicate in the form of clay so that the percentage of available silica should be accordingly reduced. Carbonates of lime and magnesia are always present, occasionally in considerable quantity. Were this deposit to be used commercially, which its distance from rail renders improbable at present, its value would be reduced by the presence of the clay and the lower percentage of silica. The basalt overlying the tripolite is compact in texture and quite fresh. It is of a variety fairly rich in olivine, with the augite and plagioclase ophitically grouped; magnetite is present as is usual in such rocks. The unaltered condition of the constituents, more especially of the olivine, testifies to the recent age, geologically speaking, of the basalt.

This is probably the deposit referred to by Professor Liversidge* as being "forty miles from Tamworth."

This earth contains *Melosira* and *Spongilla* spicules in abundance.

Other Deposits.—Numerous other small deposits occur in New South Wales of which we have no stratigraphical information, and in many cases their exact position is uncertain. Deposits said to occur at Newbridge, Blue Mountains, Mudgee, Coolah, Wellington District, Bathurst, Cungen, Tweed River, Bello Mountain near Cobbadah, are similar in being composed of *Melosira* and *Spongilla* spicules. One specimen from Newbridge contains in addition a Naviculoid genus. The richest earth, in point of contents, with which we are acquainted from New South Wales is one said to come from Paddy's River, Shoalhaven. This is a dirty white earth, and contains the common species of *Melosira* (? *arenaria*), *M. Jurgensi*, *Navicula*, *Cymbella*, and *Spongilla*. The *M. Jurgensi* does not occur, as far as we are aware, in any of the Victorian earths that have passed through our hands. The *Navicula* and *Cymbella* are similar to Victorian forms.

As regards the common New South Wales *Melosira*, there appear to be two well-marked varieties, which Mr. Etheridge, in his report before quoted, speaks of as *sp. a* and *b*. The species proper he referred to *M. orichalcea*, Smith; but, according to Van Heurck, this is the *M. crenulata* of Kützing.†

In some specimens there is evidence of denticulation along the margin, though more commonly it is plain. There are in general two marked varieties, one much narrower than the other. The two forms, as figured by Van Heurck, to which our New South Wales forms approach nearest, are *M. arenaria* and *M. granulata*, and in the coarseness of the ornamentation there is a closer approach to the latter. It is probable that the variation in length and breadth and the slight difference in coarseness of the punctation and striation is only individual, and we may consider our form to be *Melosira granulata*, Ehrenberg.

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* Minerals of New South Wales, p. 177. (8vo. London, 1888.)

† Op. cit. p. 443.

Regarding the *Spongilla* spicules nothing we think can be added to Mr. Etheridge's remarks on them. He describes them as long, slightly curved, pointed at both ends, and in some cases serrated. The axial canal is well preserved. Numerous instances of these spicules in all conditions have come under our notice. Mr. Etheridge referred all these spicules to the genus *Spongilla.*[*] Dr. G. J. Hinde, the eminent spongiologist, confirms Mr. Etheridge's opinions and adds that he saw amphidiscs which pointed to the occurrence of *Meyenia* also. The possibility of this occurrence was noted by Mr. Etheridge who did not consider he had sufficient evidence to settle the point.

Both *Spongilla* and *Meyenia* occur in Australian fresh waters.

General Summary.

From the evidence brought forward it will be seen that the stratigraphical relations, as well as their contents, point to the fresh-water origin of the New South Wales, Victorian, and Queensland diatomaceous earths, with the exception of the Yarra deposit. It will also be seen that they cannot compare in extent with those in some other countries, notably America. Their purity is to some extent inferior, and in many instances the comminuted character of the diatom tests, while perhaps favourably affecting their polishing capabilities, will tend to lessen the absorbent power. They appear to belong approximately to the same geological age, and that a late Tertiary. In the case of the Warrumbungle deposit Professor David considers the associated trachytic rocks to be of late Cretaceous or early Tertiary age. It may further be noted that the deposits in many cases owe their preservation to the basaltic or trachytic sheets by which they are or have been covered, having been thereby protected from denudation which would have inevitably swept away such soft deposits. An association with peaty material has been noticed elsewhere (Scotland), but this condition, as might be expected, does not obtain in Australia where true peat is unknown, the late Tertiary climate of Australia being unfavourable to its formation.

We have to express our indebtedness to Professor Wilson of the University of Sydney, for the loan of his microphotographic apparatus, and also to Mr. Robert Grant for the preparation of the microphotographs, some of which are reproduced on Plates XII–XV.

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[*] Ann. Rept. Dept. Mines, New South Wales, for 1887 [1888], p. 166.

PLATE X.

Pecopteris? obscura, *Dun.*

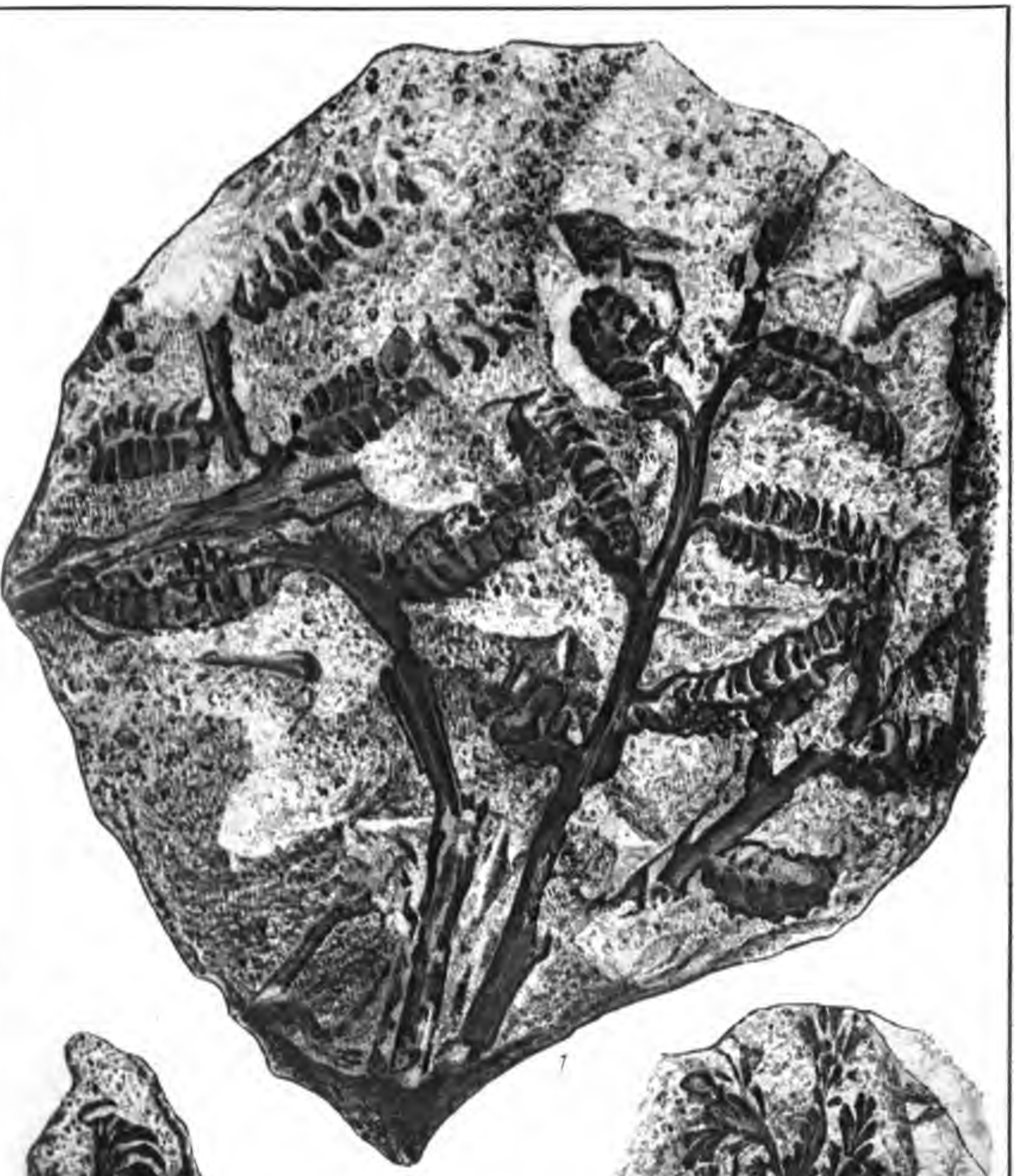
Fig. 1. Specimen showing mode of growth, and arrangement of secondary pinnæ.

Fig. 2. Fragment of a pinnæ, showing one of the pinnules in a condition which may be fructification.

Sphenopteris Carnei, *Dun.*

Fig. 3. Specimen showing incision of pinnules.

Drawn from nature by Mr. F. R. Leggatt.



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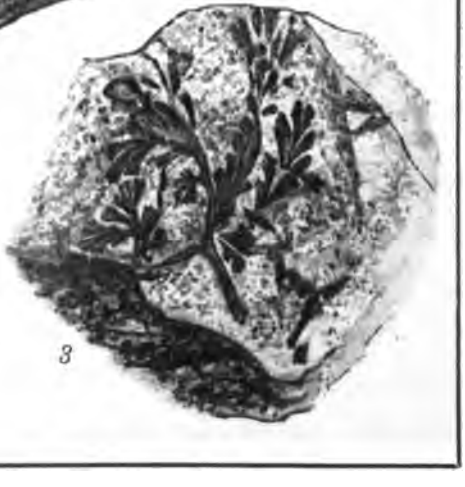

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PLATE XI.

Archæopteris Howitti, *McCoy.*

Fig. 1. Specimen showing two pinnæ.
Fig. 2. Portion of pinnæ, enlarged.
Fig. 3. Do do do

Sphenopteris Carnei, *Dun.*

Fig. 4. Specimen showing lobate and entire condition of pinnules.
Fig. 5. Pinnules enlarged.

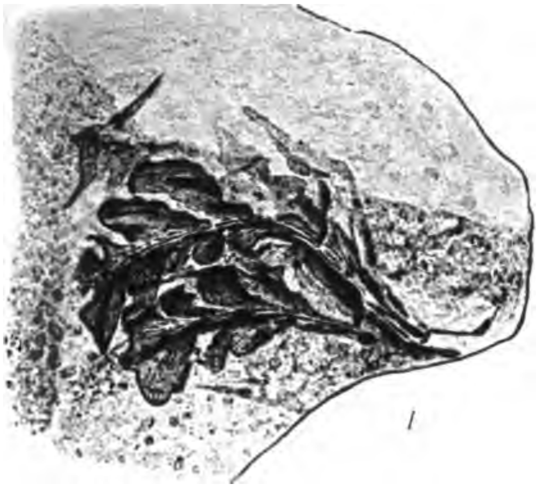
Pecopteris ? obscura, *Dun.*

Fig. 6. Portion of pinnæ, showing retracted apices of the pinnules.
Fig. 7. Portions of pinnæ.

Cordaites australis, *McCoy.*

Fig. 8. Stem, basal portion, which probably belong to this species.

Drawn from nature by Mr. F. R. Leggatt.



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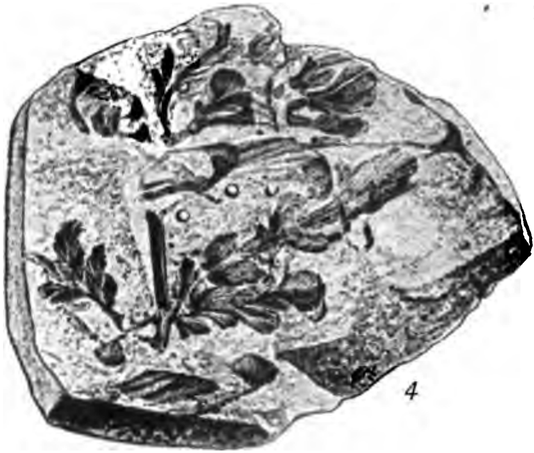

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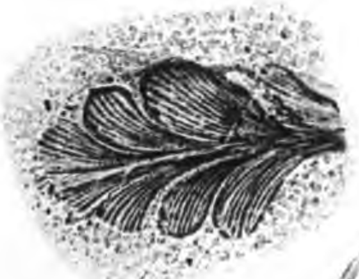

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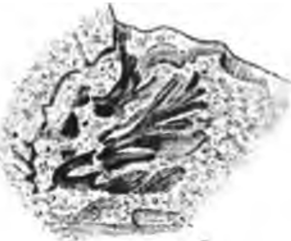

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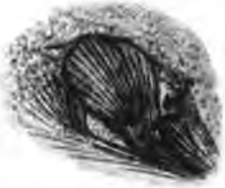

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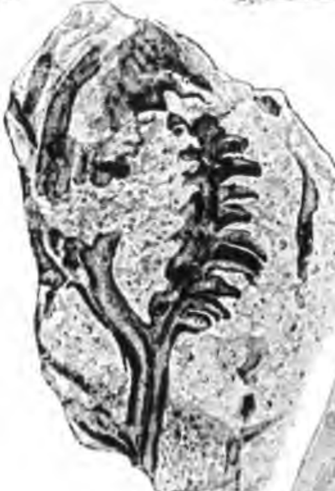

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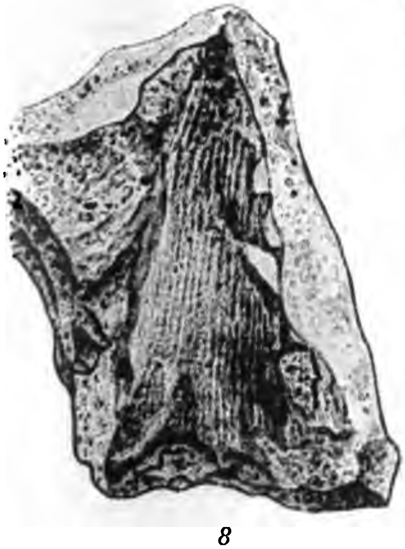

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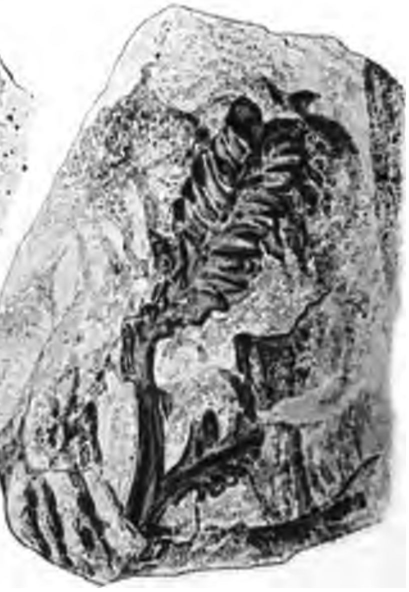

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PLATE XII.

Microphotograph of Cooma Diatomaceous Earth, showing acerate *Spongilla* Spicule and two forms of *Melosira*.

Photographed by Mr. Robert Grant, of the Medical School, Sydney University, with Beck's $\frac{1}{6}$ and Zeiss' No. 2 prg. oc. at 105 cm. = 400 diameters.

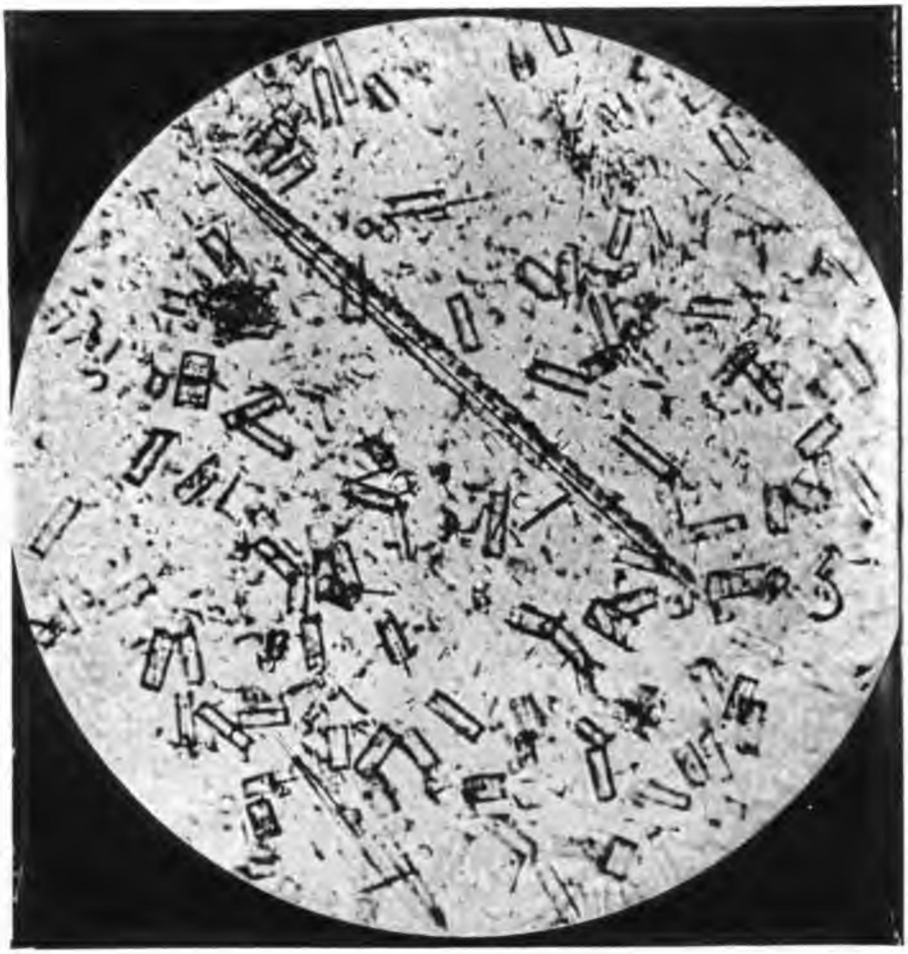


PLATE XIII.

Microphotograph of Diatomaceous Earth from Coralulup Creek, Victoria, showing *Navicula*, *Cocconeis*, *Synedra*.

Photographed by Mr. Robert Grant, Medical School, Sydney University, with Beck's $\frac{1}{8}$ and Zeiss' No. 2 prg. oc. at 105 cm. = 400 diameters.

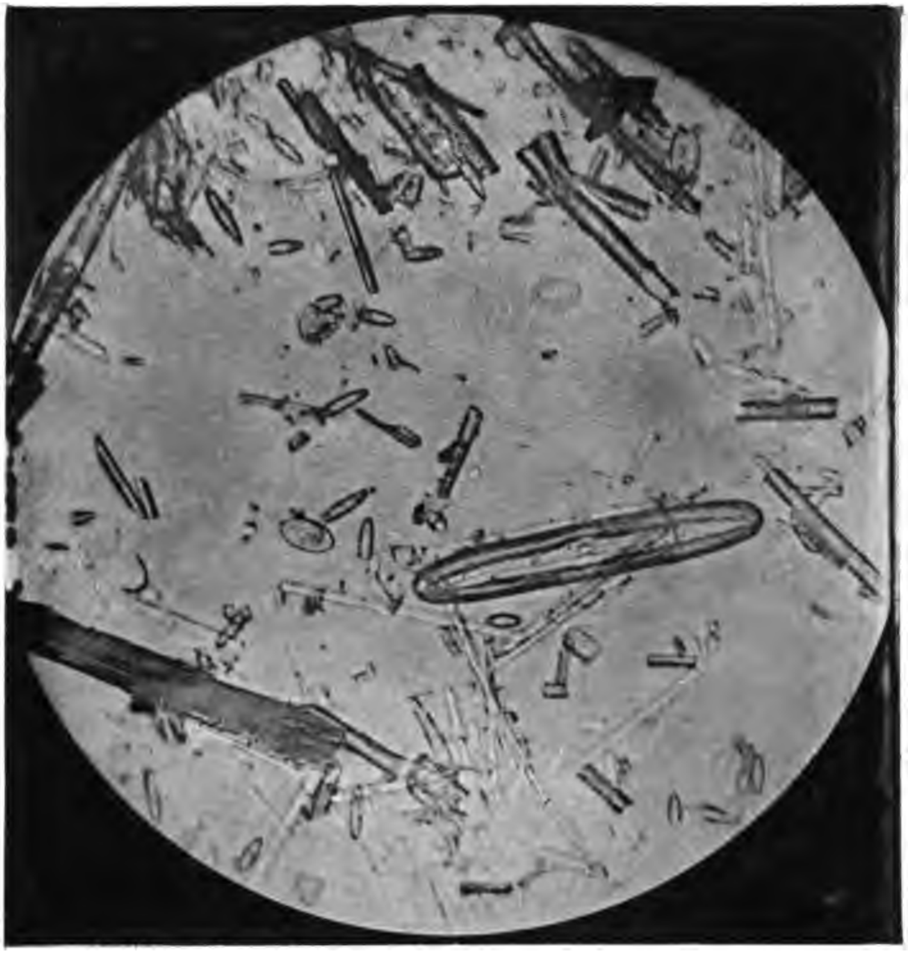


PLATE XIV.

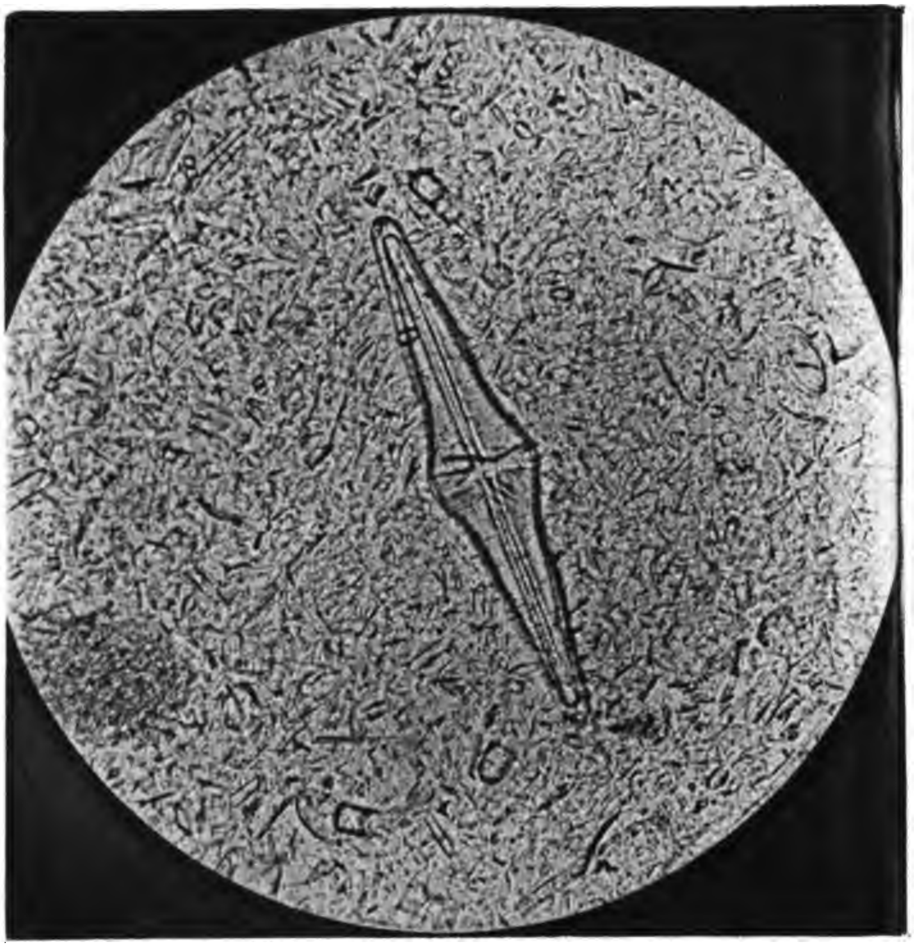
Microphotograph of Diatomaceous Earth from Coralulup Creek, Victoria, showing *Synedra* cf. *ulna*, Ehr., *Navicula*, and *Cocconeis*.

Photographed by Mr. Robert Grant, Medical School, Sydney University, with Crouche's $\frac{1}{10}$ and Zeiss' No. 2 prg. oc. at 105 cm. = 800 diameters.

PLATE XV.

Microphotograph of Diatomaceous Earth from Eglington, Victoria, showing *Stauroneis*, cf. *phœnicenteron*, Ehr.

Photographed by Mr. Robert Grant, Medical School, Sydney University, with Beck's $\frac{1}{6}$ and Zeiss' No. 2 prg. oc. at 105 cm. = 400 diameters.



GEOLOGICAL MAPS AND PUBLICATIONS ISSUED BY THE DEPARTMENT OF MINES AND AGRICULTURE, SYDNEY.

(1.) MAPS.

Map showing Mineral Areas of New South Wales. Scale, 16 miles to 1 inch.

Do do do Scale, 50 miles to 1 inch.

Geological Sketch Map of New South Wales, compiled from the Maps of the late Rev. W. B. Clarke, M.A., F.R.S., by C. S. Wilkinson, L.S., F.G.S., Government Geological Surveyor-in-charge. Scale, 8 miles to 1 inch.

Do do do do Scale, 22 miles to 1 inch.

Do do do prepared under the direction of E. F. Pittman, &c., &c., Government Geologist. Scale, 16 miles to 1 inch.

Geological Map of the Districts of Hartley, Bowenfells, Wallerawang, and Rydal, by C. S. Wilkinson, L.S., F.G.S.

Geological Map of Hill End and Tambaroora, by E. F. Pittman, Geological Surveyor.

Geological Map of the Vegetable Creek Tin-mining District, by T. W. E. David, B.A., F.G.S., Geological Surveyor. Scale, 58 chains to 1 inch.

Index Map of the Vegetable Creek Tin-fields, by T. W. E. David, B.A., F.G.S. Scale, 80 chains to 1 inch.

Geological Map of the Forest Reefs District, by H. Y. L. Brown, Geological Surveyor.

Map of the Silver-mining Country, Barrier Ranges, by C. S. Wilkinson, L.S., F.G.S.

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Diagrams showing the Thickness, Character, and Portion mined out of Coal-seams in the Coal Measures of New South Wales, by John Mackenzie, F.G.S., Examiner of Coal-fields.

Plans showing the Outcrop, Thickness, and Dip of the Coal-seams in the Northern, Southern, and Western Coal-mining Districts of New South Wales, by John Mackenzie, F.G.S., Examiner of Coal-fields.

Geological Sketch Map showing boundary of the Cretaceo-Tertiary Formation in the County of Cowper, by William Anderson, Geological Surveyor, 1889.

Geological Sketch Map of Tertiary Deep Lead, Tumberumba, by William Anderson, 1890.

Sketch Map showing Geological Features between Peak Hill and Tomingley, by William Anderson, 1890.

Geological Map showing the principal Stanniferous Leads in the Tingha and Elsmore Districts, by the late C. S. Wilkinson, F.G.S., F.L.S., and T. W. E. David, B.A., F.G.S., 1895.

(2.) PUBLICATIONS.

The Mining Act of 1881, with Regulations.

Annual Reports from 1875 to 1893 inclusive.

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1. Mineral Products of New South Wales, by Harrie Wood, J.P., Under Secretary for Mines.
2. Notes on the Geology of New South Wales, by C. S. Wilkinson, L.S., F.G.S., Geological Surveyor-in-Charge.
3. Description of the Minerals of New South Wales, by Archibald Liversidge, M.A., F.R.S., F.C.S., F.G.S., &c., Professor of Chemistry and Mineralogy in the University of Sydney.
4. Catalogue of Works, Papers, Reports, and Maps on the Geology, Palæontology, Mineralogy, &c., &c., of the Australian Continent and Tasmania, by Robert Etheridge, Junr., of the British Museum, and Robert Logan Jack, F.R.G.S., F.G.S., Government Geologist for Queensland.

Mineral Products of New South Wales, 2nd Edition, 1886, containing:— [Out of print.]

1. Mineral Products of New South Wales, by Harrie Wood, J.P., Under Secretary for Mines.
2. Notes on the Geology of New South Wales, by C. S. Wilkinson, L.S., F.G.S., Geological Surveyor-in-Charge.
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Memoirs of the Geological Survey of New South Wales.

Geology.

1. Report on the Vegetable Creek Tin Mining District, by T. W. E. David, B.A., F.G.S., Geological Surveyor.
5. Geology of the Broken Hill Lode and Barrier Ranges Mineral Field, New South Wales, by J. B. Jaquet, A.R.S.M., &c. (4to. Sydney, 1894.)

Palæontology.

1. The Invertebrate Fauna of the Hawkesbury-Wianamatta Series of New South Wales, by Robert Etheridge, Junr., Palæontologist to the Geological Survey of New South Wales, and Australian Museum, Sydney. (4to. Sydney, 1888.)
2. Contributions to the Tertiary Flora of Australia, by Dr. Constantin, Baron von Ettingshausen, Prof. of Botany, University of Graz, Austria. (4to. Sydney, 1888.)
3. Geological and Palæontological Relations of the Coal and Plant-bearing Beds of Palæozoic and Mesozoic Age in Eastern Australia and Tasmania, by Ottokar Feistmantel, M.D. (4to. Sydney, 1890.)
4. The Fossil Fishes of the Hawkesbury Series at Gosford, by A. S. Woodward, &c. (4to. Sydney, 1890.
5. A Monograph of the Carboniferous and Permo-Carboniferous Invertebrata of New South Wales. Part 1, Cœlenterata; Part 2, Echinodermata, &c.; by R. Etheridge, Junr. (4to. Sydney, 1891-92.)
7. The Mesozoic and Tertiary Insects of New South Wales, by R. Etheridge, Junr., &c., and A. Sidney Olliff, &c. (4to. Sydney, 1890.)
8. Contributions to a Catalogue of Works, Reports, and Papers on the Anthropology, Ethnology, and Geological History of the Australian Aborigines, Parts I—III; by R. Etheridge, Junr. (4to. Sydney, 1890-95.)
9. The Fossil Fishes of the Talbragar Beds (Jurassic), by A. S. Woodward, &c. (4to. Sydney, 1895.)

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DEPARTMENT OF MINES AND AGRICULTURE, SYDNEY.

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GEOLOGICAL SURVEY OF NEW SOUTH WALES.

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DEPARTMENT OF MINES AND AGRICULTURE, SYDNEY.

RECORDS

OF THE

GEOLOGICAL SURVEY OF NEW SOUTH WALES.

Vol. V.] February, 1898. [Part 4.

XXII.—A New Form of *Syringopora*, allied to *Syringopora tabulata*, Van Cleve: by R. Etheridge, Junr., Curator of the Australian Museum, Sydney.

[Plate XVI.]

The Coral about to be described—*Syringopora bellensis*—is one out of many excellent instances that exist of Australian fossils displaying a very marked structural affinity with an allied form in some other part of the world. In this case it is with *Syringopora tabulata*, Van Cleve, from the Upper Helderberg Group of North America. The specimen is unfortunately imperfect, having been fractured across the middle at right angles to its growth, leaving only the upper portion of the colony (Pl. XVI, Fig. 1), now measuring three by two and a half inches. In its present condition it is sub-hemispheric, with the corallites arranged in an irregularly fasciculate manner. They are cylindrical or tubular, and more or less circular, as is usual in *Syringopora*, with an average diameter of one-sixteenth of an inch. The mouths are sharp and unexpanded, but here and there the actual periphery of the calice is rather less in diameter than the corallite in general, giving to it a slightly contracted appearance; at other times there is an inwardly bevelled margin, giving rise to a kind of outward area, or vestibule, that is always devoid of septa (Pl. XVI, Fig. 3); but when the calice margins assume their normal character the septa extend to the very edges (Pl. XVI, Fig. 4). The distance apart of the corallites at the upper surface of the colony is variable; there may be a cluster of several, even united by their walls, or only two so joined, but their normal condition is a union with one another only by the mural expansions shortly to be noticed; thus the interstitial surface between contiguous corallites is of very uncertain and variable extent. They are surrounded by a concentrically wrinkled and annulated epitheca, the annulations being placed at unequal distances apart (Pl. XVI, Fig. 5).

Tubular connecting processes, in the usual acceptance of the term, do not exist, but their place is taken by a series of mural expansions in the same plane, completely investing the corallites. The result is that, when viewed from above, the upper ends of the corallites seem to be protruding through a shield or platform, existing at the same level all over the colony (Pl. XVI, Fig. 1). Here and there, however, the lateral extension of this expansion is limited to surrounding a few corallites, the regular succession of the mural expansions in a vertical view being thus more or less interrupted. The surface of these investments bears only here and there a few concentric wrinkles around the corallites; and although of no great thickness, they are, as will be subsequently shown, hollow, and are composed of extensions of the corallite walls. Speaking of these in *S. tabulata*, Van Cleve, Prof. Alleyne Nicholson says[*] that the mere external resemblance to that of *Tubipora* is very striking.

The septa (Pl. XVI, Fig. 4) are visible on the walls of the calices with an ordinary lens as vertical rows of fine, slender spines of no great length. It is difficult to estimate the number of rows, but they are very numerous, are quite of the Favositiform type, spiniform and never lamellar. Nicholson says[†] that the larger species of *Syringopora* seem to have as many as twenty rows, but in the present species they are much more numerous than this.

Wherever the corallites are, from the nature of their growth, brought into close contact with one another, no trace of mural pores is to be seen; indeed, according to Nicholson,[†] these structures have not been observed in *Syringopara*, but their place is taken by exothecal connecting processes, here represented by the platform-like mural expansions. Schlüter, however, has described[‡] a Devonian *Syringopora* (*S. tenuis*, Schlüter), in which the walls, wherever two corallites come in contact, are pierced by mural pores, and he figures a portion of an open corallite without tabulæ, with three mural pores one above the other.

The walls of *Syringopora* are said[§] by Nicholson to consist of two layers—an outer, light-coloured, dense stratum of indistinctly fibrous or granular sclerenchyma, and an inner, darker, and laminated or fibrous ring. In a horizontal thin section prepared for the microscope the same compact walls are visible in *S. bellensis*; but the character of the two layers seems to be reversed. The peripheral layer is dark and apparently fibrous, the inner very light in colour and laminated, or fibrous-laminar. The septa, where seen around the edges of the visceral chambers, are of the nature of thorn-like spines, slender and moderately long, but both in horizontal and vertical sections they are of the same dark colour as the outer portions of the walls, and are enveloped in the inner and lighter coloured ring, through which they protrude. As it is very seldom that the horizontal section cuts the corallites precisely at right angles, we observe many of the septa as scattered dark dots. In vertical sections these occupy their normal position in vertical rows; but according as the section under examination is taken exactly in the plane of the corallites, or a little obliquely, so will the amount of the septa be individually apparent.

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[*] Proc. R. Soc. Edinb., 1880–81, XI, No. 108, p. 224.

[†] Proc. R. Soc. Edinb., 1880–81, XI, No. 108, p. 224.

[‡] Abhl. Geol. Specialkarte Preuss.—Thür. Staaten, 1889, VIII, Heft 4, p. 171, t. 16, f. 4.

[§] *Ibid.* p. 225.

The cut edges of the invaginated tabulæ (Pl. XVI, Figs. 7–9.) are closely packed in *S. bellensis*, and by their frequent and apparent anastomosis produce a vesicular effect, the vesicles both in a horizontal and longitudinal section appearing to be unusually long and narrow, the upper surface of these tubular vesicles in a vertical section being gently convex and inclined downwards. I have not observed any horizontal tabulæ whatever, although such are stated* to sometimes exist in *Syringopora*, nor the slightest trace of septa on the inner surfaces of the descending tabulæ, another feature " not uncommonly " met with in the genus.†

The cylindrical tube (Pl. XVI, Fig. 6.) formed by the union of the funnel-shaped tabulæ, and usually stated to be central, is in the sections before me, either in this position or excentric; but the latter may possibly be exaggerated by the direction taken by the section, for in some corallites it isround, in others oval, but in all large. The tube is in places tabulate (Pl. XVI, Fig. 8.), the tabulæ being very fine, close, and concave, and some of them at least seem to be inward prolongations of the larger invaginated tabulæ. Such occurs in other species of *Syringopora.*‡

The connecting floors, whether viewed in horizontal or longitudinal section, are hollow, like the connecting processes of other species of *Syringopora*, and are to some extent filled with anastomosing endothecal tissues, generally prolongations of the tabulæ. A vertical section exemplifies how very much these floors vary in thickness and in their distance apart from one another in successive tiers.

The genera *Cannapora*, Hall, *Thecostegites*, Ed. and H., and *Chonostegites*, Ed. and H., as well as *Syringopora tabulata*, possess similar mural expansions to those just described; and it is, therefore, necessary to briefly refer to them. First, as to *S. tabulata:* The description[*] of this coral by the distinguished authors, Edwards and Haime, was confined chiefly to its external features; but they laid stress on the mural expansions. Dr. Rominger amplified[†] this description, and described the mural expansions as verticillate, " by the lateral anchylosis of which almost uninterrupted laminar floors are formed." Our coral, although closely allied to *S. tabulata,* differs essentially in the diameter of the corallites, the general size of the corallum, and in the largely increased number of rows of septal spines. Possibly, were more known of the internal structure of the American coral, a further divergence could be pointed out.

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* Nicholson, Tab. Corals Pal. Period, 1879, p. 211.

† Nicholson, Tab. Corals Pal. Period, 1879, p. 212.

‡ Nicholson, Proc. R. Soc. Edinb., 1880–81, XI. No. 108, p. 224.

In the case of *Cannapora,* we are again indebted to Rominger for a fuller description[‡] than the meagre details originally given by Hall.[§] After alluding to the special peculiarity of the floors, he adds that the calice mouths are inflated, the septa spiniform, but the tabulæ direct and horizontal, not infundibuliform; and where the corallites come in contact the walls are poriferous. Nicholson remarks that the chief distinction between *Cannapora* and *Syringopora,* and therefore equally between the former and our coral, seems to consist in the presence of those horizontal instead of infundibuliform tabulæ. On the other hand, the late Prof. Ferdinand Roemer stated that the tabulæ are seldom visible in *Cannapora*[‖]; but as Drs. Nicholson and Hinde have described[¶] a second species of the same genus, in which the tabulæ are "well developed" and horizontal, there can, I think, be little question of their nature.

Thecostegites possesses much the outward appearance of *Syringopora tabulata* and *S. bellensis,* with the same exothecal expansions; but horizontal tabulæ are present, a point on which Nicholson,[**] Zittel,[††] and Roemer[‡‡] agree. If so, *Thecostegites Bouchardi,* and *Syringopora tabulata* cannot be the same, a point already brought forward by Roemer,[§§] and for the same reason our *S. bellensis* is not a *Thecostegites.* I do not find any mention of true mural pores in the latter, not even to the same extent as in *Cannapora.* Edwards and Haime distinctly state[‖‖] that there was communication between the corallites, whilst Roemer is silent on the matter. Nicholson remarks[¶¶] that in *Thecostegites* the periodic floors are, as in *Chonostegites,* so far exothecal that they are hollow expansions from the walls of the corallites, and filled with prolongations of the endothecal tissues of the corallites themselves. The same language might also be applied to the form now under consideration.

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[*] Archiv. Mus. Hist. Nat., 1851, p 288 t. 15 f. 3 *a* and *b*.

[†] Report Geol. Survey Michigan. Lower Peninsula, 1876, Pt. 2, p. 84.

[‡] *Loc. cit.*, p. 86.

[§] Pal. N. York, 1852, II, p. 43.

[‖] Lethaea Palaeozoica, 1883, Lief. 2, p. 498.

[¶] Pal. Ontario, 1875, II, p. 58.

[**] Tab. Corals Pal. Period, 1879, p. 205.

[††] Traité Pal.-I. Paléozoologie, Pt. 1, 1883, p. 243.

[‡‡] Lethæa Palaeozoica, 1883, Lief. 2, p. 499.

[§§] *Ibid.*, p. 499.

[‖‖] Archiv. Mus. Hist. Nat., 1851, V, p. 297.

[¶¶] Palæontology, 3rd edit., 1889, I, p. 322.

Lastly, as to *Chonostegites.* The appearance and mode of growth of the latter and *S. bellensis* closely resemble one another, even to the annulation of the corallites, as well as the periodic expansions. Wherever the walls of contiguous corallites come in contact, the former become pierced by mural pores, as in *Cannapora.* The tabulæ are arched, "often uniting with one another in such a way as to give rise to a loose and open subvesicular tissue, which is continued into the hollow periodic expansions of the corallites."* This produces, in longitudinal sections, a totally different appearance to that seen in *S. bellensis*, the lenticular cells of the one, produced by the inosculation of the tabulæ, being quite different from the highly inclined vesicles formed by the infundibuliform tabulæ of the other. In *Chonostegites* the surfaces of the tabulæ are septate, but I have not observed this in *S. bellensis.*

This interesting form is from the Siluro-Devonian Limestone of Wellington, New South Wales, and is contained in the collection of the Geological Survey of New South Wales. The River Bell, after which it is named, passes in front of the limestone escarpment containing the Wellington Caves.

XXIII.—Saddle Reefs at Hargraves: by J. ALEX. WATT, M.A., B. Sc., Geological Surveyor.

I.—*Introduction.*

HARGRAVES, a once prosperous mining township, is situated on Louisa Creek, a tributary of Meroo Creek, and is distant fifteen miles in a direct line south-west of Mudgee, but twenty-four by the coach road, and about one hundred and twenty-eight miles (as the crow flies) north 35° west from Sydney.

During a recent visit to this township, I had an opportunity of making a hurried examination of certain reefs that were being worked not more than a few hundred yards westerly of the post office.

---

* Nicholson, Tab. Corals Pal. Period, 1879, p. 152.

Before proceeding to describe the reefs, I have much pleasure in acknowledging my indebtedness to Mr. Spratt, not only for his kindness in conducting me over the ground and through the workings of the mine in which he is interested, but in communicating to me his opinion, with the evidence on which it was based, that the ore bodies were of the nature of saddle-reefs. Before my examination had proceeded far, I was able to thoroughly endorse this opinion, and to offer certain suggestions, based on this theory of their nature, with reference to the course future prospecting operations should take.

Saddle-reefs may be described as saddle-shaped bodies of quartz filling cavities in the anticlines and synclines (especially the former) of folds, in which the reef material conforms to the strike and dip of the enclosing strata. They occur in sharply folded sedimentary rocks, the constituent beds of which, in the process of bending, have opened out, often along the junction of two kinds of rock, *e.g.*, at the junction of slate and sandstone at Bendigo. By this means cavities are produced both in the anticlines and synclines of the folds, the greatest amount of separation of the strata usually taking place in the neighbourhood of the "centre country," and perhaps more frequently in the upper beds of the anticlines than elsewhere.

Saddle-reefs consist of three parts, known as the "cap" and the two "legs," the former, in true saddle reefs occurring in anticlinal arches, being the upper flat-lying portions, while the latter are the steeply-dipping lateral extensions which gradually pinch out as they are followed from the cap.

This variety of deposit is, as far as our present knowledge goes, confined to Australia. The most typical examples, and those to which the name was first applied, occur at Bendigo, in Victoria, where reefs of this description are very numerous and of very great economic importance. These have been described by Mr. T. A. Rickard,* and more recently by Mr. E. J. Dunn.†

In New South Wales the celebrated Broken Hill lode has been described by Mr. Pittman‡ as a deposit which fills a more or less saddle-shaped space produced by the folding of gneiss. This view was adopted by Mr. Jaquet in his Memoir on this lode,§ where sections through several of the shafts are given showing the division of the lode at varying distances from the surface into two branches by what he believes to be the "centre country" of an anticlinal fold.

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* Trans. Am. Inst. Mining Eng., 1892, xx pp. 463–545.

† Dept. Mines Vict., Reports on the Bendigo Gold-field, Report No. 1, Nov. 1892; No. 2, July, 1896.

‡ Records Geol. Survey N. S. Wales, 1892, III, Pt. 2, p. 45.

§ Mem. Geol. Survey N.S. Wales, Geol. V, 1894.

This theory of the character and origin of the Broken Hill deposit has met with a varied reception. Amongst those who have adversely criticised it may be mentioned Mr. E. J. Dunn,* who, while giving no reasons in support of his objections, makes the following statement in a short but severe paragraph, which I quote in full:—"In many cases reefs and lodes that bear not the least resemblance to saddle reefs are described as such. The great fissure lode of Broken Hill has been thus confounded through a total misconception of what really constitutes a saddle reef."

In support of Mr. Pittman's theory, Mr. Danvers Powers† states, from his own personal experience, that "at one time the nature of this lode could be seen in the workings of the open cut as if drawn on a giant blackboard, while below ground I have seen perfect subsidiary saddles in the 'centre country.'"

II.—Previous Reference to the Hargraves Saddle Reefs.

Considering the interesting character of these reefs, and the almost perfect manner in which they illustrate this class of deposit, it is surprising that so little notice has been taken of them. The earliest reference to them, as far as I am aware, is that contained in a letter from Mr. Geological Surveyor Jaquet to the Government Geologist, dated 16th August, 1894, in which Mr. Jaquet says:—"I have had my attention called here [Hargraves.—J. A. W.] to what appears to me to be undoubted saddle reefs; in fact, the big reef (Big Nugget Reef), which runs just behind the town, has all the characteristics of these ore deposits. In a small shaft, fifteen feet deep, sunk on the same line of reef, they have struck a reef in which the cap and legs can be clearly seen; moreover, they have put a drill hole down through the centre of the cap, and at a depth of six feet below the bottom of the shaft they have struck another flat-lying body of quartz (a second saddle?). On another claim, about three hundred yards west of the main line of reef, they have met with another saddle reef, where the cap and legs can be seen (a second line of saddles?). The rolling over of the country is not apparent."

Mr. Jaquet again refers to these reefs in his Progress Report for 1894,‡ where he says:—"I found some of them to closely simulate the so-called saddle reefs which occur at Bendigo, Victoria, and I wrote you to this effect. The large reef running behind the town, which yielded when worked many years ago by an English company, large quantities of gold, and from which the famous 'Blackfellow's Nugget' was obtained, would seem to belong to this class of deposit. I am of opinion that shafts should be sunk through the quartz cap of this reef, for the purpose of proving whether other reefs occur beneath it."

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* Dept. Mines Vict., Report on the Bendigo Gold-field, 1896, No. 2, p. 23.

† Trans. Austr. Inst. Mining Engineers, 1897, IV, p. 29.

‡ Ann. Rept. Dept. Mines & Agric. N. S. Wales for 1894 [1895], p. 137.

The only other reference to these reefs is that contained in a report by Mr. Slee, Chief Inspector of Mines, dated 24th September, 1894,* where he makes the following remarks:—

"Here [on Warry and Stuart's lease.—J.A.W.] the real saddle reef, similar to those on the Bendigo Gold-field, occur; and I have no doubt that if those interested in mining in the Hargraves district would study this system, which hitherto has been greatly neglected, numbers of persons would receive payable returns for labour and capital expended. Warry and Stuart obtained their crushing from the top of the saddle, about four feet in thickness. The strike of these saddles is about 20° east of south, the legs under lying east and west at an angle of about 20°. About ten feet from the saddle the legs average from eighteen inches to twenty inches in thickness, and, as so far the eastern legs have been worked by former companies, it is of the utmost importance to the district that the western legs should also be tested, as there is no reason whatever why the western legs of these saddle reefs should not yield as large returns of gold as the eastern. A shaft sunk twenty feet south of Warry and Stuart's, which was sunk by the Old English Company some forty years ago, and which has never been worked since, shows within forty feet of the surface, three perfect distinct saddle reefs, which have only been sunk through and left for the present generation to develop; and as these saddle reefs can be traced for a considerable distance north and south from the Big Nugget Hill, and as at least three of these saddle reefs have already been exposed to view, though apparently unnoticed for the last forty years, more of these saddles may be discovered at a greater depth, and an unlimited quantity of payable quartz—which has hitherto been looked upon as worthless—may be the means of profitably employing a large number of persons. Spratt and Milton, south of Warry and Stuart, struck the first saddle reef yesterday in a shaft about thirty feet in depth."

III.—Surface Features.

On the western side of the village of Hargraves is Big Nugget Hill, a slight eminence on which the cap of the Big Nugget Reef outcrops. This was the site, I believe, of the discovery in July, 1851, by an Aboriginal in the employ of Dr. Kerr, of a large mass of gold and quartz, about three hundred pounds in weight, which contained about a hundred-weight of gold. A considerable portion of the cap and east leg of this reef has been removed by an open-cutting along its strike. The true dip of the strata and enclosed reef cannot be made out at the sides of this open cutting, but at its southern end an excellent section (Figure 1) of the cap of this reef is exposed, where it can be seen to lie conformably between bedding planes of slate, and to exhibit distinct evidence of bending over in opposite directions.

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* Ann. Rept. Dept. Mines & Agric. N.S.Wales for 1894, [1895] pp 77, 78.

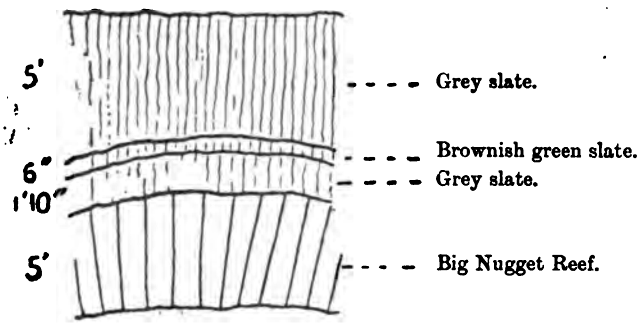

Fig: 1

SCALE 0 8 FEET

The cap of the reef consists of white quartz, is five feet thick, and, while at the centre it lies practically horizontal, at the east and west ends of the exposure it dips slightly east and west respectively. Immediately overlying the reef is a band of grey slate one foot ten inches in thickness; above this is a well-marked band, six inches in thickness, of brownish-green slate, which is capped by five feet of grey slate.

The change in the colour of the slates, not due to surface action alone, marks distinctly the position of the planes of stratification. These would otherwise have been difficult of recognition, for in this "centre country," as it is called, cleavage is highly developed with planes nearly perpendicular.

A little distance to the south of the just-mentioned open-cutting, there is a patch of ground from which the soil and subsoil have been removed and washed for gold. There the folding of the country could be readily made out, and that in spite of the highly developed state of the cleavage planes. The slight inequalities in the surface of the ground furnish natural sections of sufficient extent to enable one, standing ten to twenty yards away, to make out the bending over of the slates in opposite directions from a central line. To the east and west of this line there is clear evidence that the slates dip east and west respectively, and even within a short distance from the axis of the fold the angle of dip is steep.

The whole of the surface evidence, as well as that obtained from the underground workings, tends to show that the anticlinal fold is an exceedingly sharp one; its cap appears to be not more than ten to fifteen feet wide.

The strike of the fold between the crown of Big Nugget Hill and the most southerly point where it was observed is 10° west of north and east of south. The axis of the fold is not horizontal; for at one point the cap of the Big Nugget Reef was found to be six feet above the general level of the surface, and at one hundred and twenty feet south of the first point it lies six feet below the surface.

There is thus a "pitch" of one in ten, or of 6° from the horizontal plane. Should this amount of "pitch" be maintained, and the Big Nugget Reef extend as far as the patch of ground mentioned previously, where the soil and subsoil had been removed and washed for gold, its cap would lie at least fifty feet below the surface.

There is evidence at the surface of at least five saddle reefs, in addition to which the under-ground workings on Big Nugget Hill have proved the existence of two others, making seven in all. These will now be described in detail.

IV.—Description of the reefs.

To illustrate the relative positions of the saddle reefs, the ideal section (Figure 2) has been drawn. This is taken at right angles to the axis of the fold, and across the bared patch of ground, where the centre of the anticline was easily located. The reefs have been numbered in descending order, commencing with the highest.

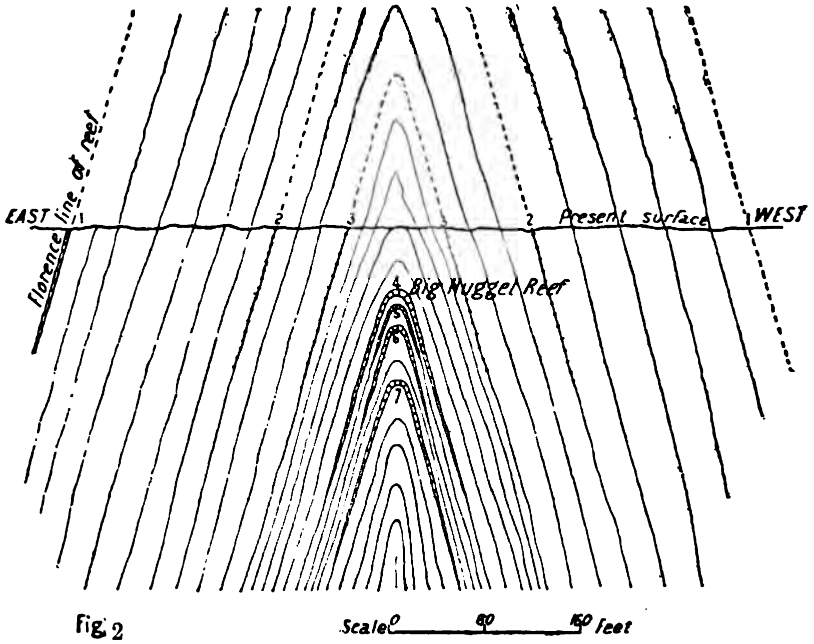

Fig. 2

Ideal section across the Fold—showing the Saddle Reefs.

No. 1. Ninety yards east of the centre of the fold is the "Florence" line of reef. This reef has been worked for some considerable time. It averages eighteen inches in width, and several parcels of stone from it have yielded from 17 dwt. to 1 oz. of gold per ton. This was not being worked at the time of my visit, because the party of miners previously working it had found it impossible to cope with the water.

It must be confessed that there is no direct evidence to show that this reef represents the denuded east leg of a saddle reef; but there is a strong probability that this is so, for at about a corresponding distance on the opposite or west side of the axis of the fold, a rich shallow alluvial lead has been worked. This exactly occupies the site where the western leg might be expected to occur, but owing to a thickness of six or more feet of soil the reef itself does not outcrop at the surface. From this site the surface rises gently, going westward, but no gold has been found higher up. As far as I am aware, this site has not been prospected for the reef that might reasonably be expected to exist there, it may be in a pinched condition.

No. 2. Rather more than thirty yards on each side of the axis of the fold are the denuded east and west legs of a saddle reef; the east leg is from three to four inches in width, and from it, I was informed, a party of men obtained in three days as much as £900 worth of gold. The west leg, which is from four to six inches in width, yielded "fair wages" to a party of miners. I think there can be little doubt about these two reefs having originally formed part of a saddle reef, whose cap must have stood originally about 300 feet above the present surface.

No. 3. This is a very small reef, from four to five inches in width, the denuded legs of which lie about thirteen yards on each side of the axis of the fold. The cap of this reef, which has not been worked at all, probably stood originally one hundred feet above the present surface.

Of the foregoing three reefs (Nos. 1, 2, 3) we have only the evidence of their denuded legs, or what appear as such. And here it should be pointed out that although these reefs are narrow where they are now seen, they may have been of considerable thickness in their upper portions, especially at their caps. The denudation of these reefs, and perhaps, of others of smaller dimensions, probably furnished a great part of the alluvial gold found in the neighbourhood.

No. 4. Figure 3 is a section showing the relative positions and extent, as proved by the underground workings, of the saddle reefs Nos. 4, 5, 6, and 7.

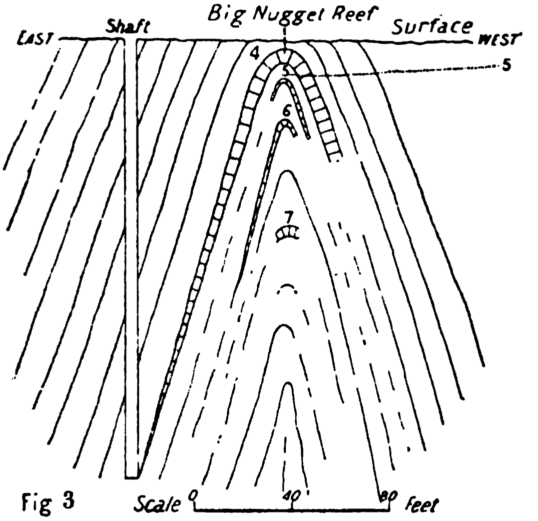

Fig 3

Section of Saddle Reefs—worked by Spratt and party.

Big Nugget Reef (No. 4) is the largest of the Hargraves saddle reefs at present known, being at least five feet thick at the cap. A shaft one hundred and eighty feet in depth and at a distance of sixty feet from the axis of the fold has cut its east leg where it pinches out. In this shaft the country dips at an angle of about seventy-five degrees. The gold contents of this reef near its outcrop are said to be from 4 to 6 dwts. per ton; but a rich shoot of ore has been worked in the eastern leg. This was from forty to fifty feet wide, and pitched at a low angle to S.S.E. The west leg has been worked to a depth of forty feet.

No. 5. Five feet below the Big Nugget Reef is a saddle reef of small dimensions varying from six to eighteen inches in thickness, and consisting of quartz of rather low grade.

No. 6. This saddle reef is situated fifteen feet below No. 5, and varies in width from eighteen inches to two feet. Several small crushings recently taken from it yielded as much as 2 oz. of gold per ton. The eastern leg has been worked for a distance of eighty feet from the surface, where it was found to pinch out. The western leg has been followed down to a depth of thirty-six feet.

No. 7. This is the last reef discovered, its cap being only recently cut in the workings seventy feet from the surface, where it was four feet thick.

A more detailed study than it was possible for me to make would undoubtedly bring to light many interesting facts which have escaped my notice. Such an examination would be of great assistance to the mining community of Hargraves, and might be the means of important discoveries being made. The general character of the work done on these reefs makes it very evident that their mode of occurrence and other characteristics are not generally understood by the local miners.

XXIV.—Notes on the Fauna of the Devonian Boulders occurring at the White Cliffs Opal-fields; by W. S. DUN, Assistant Palæontologist.

[Plates XVII, XVIII.]

IN 1892 Mr. J. B. Jaquet examined the White Cliffs Opal-fields, and drew attention* to boulders occurring in the Upper Cretaceous Beds. A collection of these boulders was made by Messrs. J. B. Jaquet and C. Cullen, Collector to the Survey, and an examination of the fossils contained in them proved that they were of Devonian age. Mr. Jaquet makes the following remarks on their occurrence: "Scattered in an erratic manner through the beds of clay and conglomerate, and lying on the surface of the ground, are enormous waterworn boulders of close-grained vitreous-looking sandstone. Some of these boulders are impregnated with oxide of iron, and have, in consequence, a deep brown colour, while others are free from this substance. When broken, in some cases thin veins of opal are seen ramifying through them, and their peculiar vitreous appearance is no doubt due to hydrous silica having been deposited in the interstices of the sandstone. I found in some of these boulders abundant impressions of characteristic Devonian mollusca and other invertebrates. . . . . The question will be asked, "Where did these boulders come from"? About twenty miles westward of the opal-field there is a large elevated area of Palæozoic rocks. These rocks consist of two series, the one consisting of very old slates, having an almost vertical dip, and the other of conglomerates and sandstones, lying uncomfortably on the first series. I think the boulders have been derived from the conglomerates and sandstones."

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* Ann. Rept. Dept. Mines and Agric. N. S. Wales for 1892 [1893], p. 141.

These fossils comprise Brachiopoda, Pelecypoda, Gasteropoda, Cephalopoda, and Pteropoda, preserved as casts and impressions, nearly always more or less imperfect, so that the determinations have been made in most cases with a great deal of uncertainty, and in nearly all cases it has been almost impossible to make satisfactory comparisons with fossils from other localities.

Some indefinite casts, dendroid and circular in outline are present in the quartzite. The origin of these is uncertain, they may be either Polyzoan or Cœlenterate.

The Brachiopoda are more numerously represented, but with a few notable exceptions they are unsatisfactory. They comprise:—

Orthis (Schizophoria) convexa, *Dun.*
„ „ sp. ind.
Chonetes, sp. ind.
Pentamerus (?)
Rhynchonella pleurodon, *Phillips.*
„ sp. ind.
Spirifera Jaqueti, *Dun.*
„ sp. ind
Athyris sp. ind.
Gen. et sp. ind.

Of these by far the most numerous and best preserved is the *Spirifera Jaqueti.*

The Pelecypoda are also fairly common and as far as their external structure goes are better preserved. They include several genera not previously recorded from Australia. They are:—

Actinopteria australis, *Dun.*
Lyriopecten gracilis, *Dun.*
Pterinea (?)
Leptodesma inflata, *Dun.*
,, obesa, *Dun.*
Orthonota.
Grammysia.
Myophoria (?)
Cucullæa (?)

The Gasteropoda are most unsatisfactorily preserved, fragmentary, and as internal casts. They are of no stratigraphical value:—

Murchisonia, sp. ind.
Loxonema, sp. ind.
Euomphalus Culleni, *Dun.*

The widely distributed Pteropod *Tentaculites* occurs in considerable numbers.

Amongst the Cephalopoda are undeterminable species of *Orthoceras* and *Goniatites*

From the genera of Brachiopoda and Pelecypoda present, there, I think, can be no doubt as to the age of the beds that yielded these boulders, and in spite of the unsatisfactory nature of their contents, I am disposed to place them either at the top of the Middle Devonian or as Upper Devonian, but of greater age than the Mount Lambie horizon. On the other hand they offer a more recent facies than that of the Burdekin Beds of Queensland, which have been classed by Messrs. Jack and Etheridge as of Middle Devonian Age, and which are doubtless, very nearly, if not quite, of the same age as the limestones of the Tamworth District and the New South Wales Siluro-Devonian limestones as has been pointed out by Professor David.*

BRACHIOPODA.

Genus.—ORTHIS, *Dalman*, 1828.

(K. Sv. Vet. Akad. Forhandl., 1827, pp. 93, 96. t. 1, 2.)

Subgenus.—Schizophoria, *King*, 1850.

(Mon. Permian Foss. England, p. 106.)

Schizophoria convexa, *n.sp.*

(Pl. XVII, figs. 3, 5.)

Several casts of ventral valves of this form showing the internal structure as well as the outward appearance are in the collection.

The shell is of medium size, transversely elliptical, hinge-line shorter than the width of the shell. Area of valve not seen. In the ventral valve the position of dental plates is well marked and the position of the obovate, elongate area of muscle attachment is shown in the figures, bounded by a well-marked groove representing in the original a strong ridge. The greater portion represents the attachment area of the divaricator muscles. Occupying a median position between the two divaricators is to be seen, rather indistinctly, a slight raised portion, in the cast, showing the point of attachment of the adductor muscles. The direction of the dental plates is very divergent. But little of the hinge line can be seen. The surface of the valves is ornamented by numerous radiating ridges, primary and secondary, the secondary starting on the lower slope of the convexity. Sometimes even a third series occurs near the margin. There is no trace of any sinus in the valve.

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* Procs. Linn. Soc. N. S. Wales, 1897, XXI, Pt. 4, p. 569.

It is with some doubt that this species is placed under *Schizophoria*; what little is known of the position of the dental plates and the general form of the divaricator scars approximating to conditions obtaining in that genus.

In 1850, King proposed[*] that Orthids of the type of *O. resupinata* should be included in a new genus, or subgenus *Schizophoria*, possessing typically "an open fissure, often rounded umbones, large punctures, and the valves in general arcuately triated in the cardinal lateral regions." Between *Orthis resupinata* Martin, so common in Carboniferous Beds, and *O. striatula*, Schlotheim, there is little difference, and Davidson in his Devonian Monograph[†] says, after a discussion of the synonymy of the species, that "it is, however, very possible and probable, that *O. striatula* is a smaller variety of *O. resupinata*." One thing certain is that our species is not a typical *striatula*[‡] or *resupinata* on account of the relatively greater length of the hinge line, and the absence of a sinus in the ventral valve.

The subgenus has a range, in America from the Clinton, through the Lower Helderberg, Corniferous, and Hamilton up to the Coal Measures.

Schizophoria, sp. ind.

(Pl. XVII, fig. 1.)

In the collection from White Cliffs are several specimens of single valves similar to that figured in Pl. XVII, Fig. 1, that are taken to be the impressions of pedicle valves of an *Orthis* and belonging to the sub-genus *Schizophoria*. The cavities left by the dental lamellæ are shown. The outline, as preserved, is of the same general type as that of *Orthis* (*Schizophoria*) *Swallovi*, Hall,[§] from the Burlington Limestone, there being the same rounded cardinal angles, fine and closely striated surface and indications of concentric growth ridges; it is also of the same general size. The species bears no resemblance to the Devonian forms figured by Hall.[‖]

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[*] Permian. Foss. England, p. 106.

[†] Brit. Foss. Brach., II, p. 90; see also Hall's description of the genus, Pal. N. York, 1892, VIII, Pt. 1, pp. 211-213.

[‡] Davidson, *Op. cit.*, pp. 87-90, pt. XVII, figs. 4-7.

[§] Pal. N. York, 1892, VIII, Pt. 1, VI, figs. 23, 24; Pal. Iowa, 1858, I, Pt. 2, p. 597, XII, fig. 5.

[‖] *Op. cit.*, pls. VI, VI A.

Genus.—LEPTÆNA, *Dalman*, 1828.

(K. Sv. Vet. Akad. Handl., 1827, pp. 94–96, 106, 107.)

Leptæna rhomboidalis, *Wilckens* (?)

Davidson, Brit. Foss. Brach., III, p. 281–283 (*for synonymy*).

(Pl. XVII, fig. 11.)

I have little hesitation in referring to this cosmopolitan species the specimen figured on Pl. XVII, Fig. 11. It represents an imperfect brachial valve, distorted, showing the cardinal process and the septum, and also the characteristic concentric wrinkles.

A detailed summary of the reasons for transferring this well-known species from *Strophomena*, under which it has been placed by Davidson and many others, will be found in Professor Hall's "Introduction to the Study of the Palæozoic Brachiopoda."*

The species is common in Australian Silurian and Siluro-Devonian rocks. The variety *analoga*, Phillips, is common in the Carboniferous.

Genus.—CHONETES, *Fischer de Waldheim*, 1837.

(Oryct. Gouv. Moscou, Pt. 2, p. 134.)

Chonetes, *sp. ind.*

(Pl. XVII, fig. 15.)

An impression of the pedicle valve of an undeterminable species of *Chonetes* is represented in the collection. This is one of the finely-striated species, the hinge line is very oblong, and, as preserved, the valve is only moderately convex. On one side is seen the indistinct trace of the ridge bounding the divaricator muscle scar. Had this mark been more intense, it would have pointed to the specimen being one of the Strophomenidæ, and have represented the position of the dental plates. However, the general appearance of the impression points rather to its being a *Chonetes*, allied to *C. hardrensis*, Phillips† from the Devonian of England. It also agrees in general size and number of striæ with Davidson's figure‡ in his Devonian Monograph, one of Phillips' original specimens from the Upper Devonian.

Mr. R. Etheridge has described a *Chonetes* from the Carboniferous of Queensland as *C. cracowensis*, which in general form is very similar to the White Cliffs specimen. *C. cracowensis*, Eth. is separated from *C. Laguessiana* of De Koninck

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* 1892, pp. 279–280.

† Pal. Foss. Dev. Cornwall, 1841, t. 58, f. 104.

‡ Brit. Foss. Brach. III, t. 19, f. 7.

(which the latter Author considers to be Davidson's Carboniferous. *O. hardrensis*).* Mr. Etheridge separates *O. cracowensis*† on the strength of the flatter cardinal angles and more spinose nature. Mr. R. Etheridge, jun., concurs in this opinion, still keeping the species separate.‡

Genus.—PENTAMERUS, *J. Sowerby*, 1813.

(Min. Conch., I, p. 76.)

Pentamerus (?).

(Pl. XVII, fig. 9.)

I cannot see any other genus except *Pentamerus* to which this small specimen can be referred, at any rate as far as our present knowledge goes. The shell appears to have been strongly convex, with a curved hinge-line, prominent beak, and with two very large septal plates, slightly diverging, in the brachial valve, extending for considerably more than one-half the length of the shell. These septal plates are widely separated to the extent of nearly a third of the width of the shell. I can find no figure of a pentameroid showing a similar disposition of these plates, still there appears to be no other genus under which it will come. There is little doubt that it is a new species, still the material is too limited to enable a satisfactory diagnosis to be drawn up. The main character of value for separation is the distance apart of the septal plates.

Genus.—RHYNCHONELLA, *Fischer*, 1809.

(Nat. Foss. Gouv. Moscou, p. 35.)

Rhynchonella pleurodon, *Phillips.*

(Pl. XVII, fig. 16.)

Terebratula pleurodon, Phillips, Geol. Yorkshire, 1836, II, p. 222, pl. XII, figs. 25–30.

Rhynchonella „ Davidson, Brit. Foss. Brach., II, pp. 101, 246, pl. XXIII, f. 1–15, 16–22 (*for Synonymy*). *Op. cit.*, III, p. 62, pl. XII, f. 12–13.

„ „ De Koninck, Foss. Pal. N. Galles du Sud, 1876, Pt. 2, p. 95; *id.*; *ibid.*, 1877, Pt. 3, p. 219, t. 9, f. 4.

„ „ Etheridge, R., junr., Cat. Austr. Foss., 1878, p. 54.

„ „ Etheridge, R., junr., Geol. and Pal. Queensland, 1892, p. 244, pl. II, f. 23.

A few impressions indicate the presence of this common and widespread Brachiopod. The specimen figured represents part of the pedicle valve, showing the well-marked sinus containing four strong ribs.

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* *Op. cit.*, II, p. 186, t. 47, f. 12–25.

† Quart. Journ. Geol. Soc., 1872, XXVIII, p. 336, t. 18, f. 2.

‡ Geol. and Pal. Q'land, 1892, p. 262, t. 13., f. 9.

This species has a world-wide distribution in rocks of both Devonian and Carboniferous age. Only a few of the more important references are given in the synonymy.

In Australia it is particularly abundant in the Upper Devonian Beds of Mount Lambie and the surrounding district, Sunny Corner, Henbury Hill (near Rylstone), Sugar-loaf Mountain (Clyde), Eden, Sofala. It has also been collected from Carboniferous beds in New South Wales and Queensland.

Rhynchonella, *sp. ind.*

(Pl. XVII, fig. 4.)

This specimen is taken to represent part of a very broad wedge-shaped *Rhynchonella*, after the type of *R. trilaterata*, De Koninck, from the Carboniferous of Belgium and England, as figured by Davidson,[*] than which it is much larger and relatively wide. It also somewhat resembles *R. cuneata*, Dalman,[†] a widely-distributed Silurian species; but from this also it is separated by the width. The surface is strongly ribbed; in the wide sinus there appear to be at least four ribs. The last-mentioned species is taken as the type of Prof. James Hall's *Rhynchotreta*.[‡]

Genus.—SPIRIFERA, *Sowerby*, 1815.

(Mineral Conchology, II, p. 42.

Spirifera Jaqueti, *sp. nov.*

(Pl. XVII, figs. 2, 12, 13, 14, 17.)

Shell small, hinge-line the width of the shell, cardinal angles rounded, valves equally convex. Dorsal valve with well-marked mesial fold, flattening towards the margin; on either side of the fold are four or five well-marked radiating ridges, with a fainter one near the cardinal angle. Ventral valve has a deep sinus, with generally five well-marked ribs on either side, and sometimes there is a faintly-marked sixth rib at the margin near the cardinal angle. The umbo is well marked and slightly overhangs the area, which is not very high; traces of the triangular dethyrium are to be seen in one specimen. From several of the casts it is evident that the dental plates of the pedicle valve are short and thick, leaving well-marked hollows. No other points of the internal structure can be made out. Average dimensions, 15mm. broad, 8 long.

This *Spirifera* may, I think, be considered to be specifically and generically distinct from such forms as *Spiriferina cristata* of the European Devonian. At first sight the general appearance is so similar to that of specimens of *Spiriferina cristata*, figured by Davidson from the Devonian,[§] that were it not for the want of shell structure showing punctæ and a median septum, it would be, perhaps, safer to class them under a variety of that variable and wide-spread genus. At the same time, Professor James Hall and Clarke's[*] remarks on this matter must not be overlooked. They say, speaking of the evolution of *Spiriferina* from "the lamellose-septate Spirifers, whose inception dates from the faunas of the Upper Silurian. Though none of these Silurian and Devonian species, in the American faunas, developed a punctate shell structure, they usually bear the lamellose, often radially striated exterior, prevailing among the Spiriferinas of the Carboniferous. Mr. Davidson has described two of these lamellose species from the Devonian, which have a strongly punctated shell, *Spiriferina cristata*, Schlotheim, var. *octoplicata* and *S. insculpta*, in which it has not been conclusively shown that the median septum exists, though this is a legitimate inference."[†]

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[*] Brit. Foss. Brach., II, p. 109, t. XXIV, figs. 23–26.

[†] *Op. cit.*, III, p. 164, t. 21, figs. 7–11.

[‡] Ann. Rept. N.Y. State Mus. Nat. Hist., 1879, XXVIII, p. 166; Pal. N. York, 1892, VIII Pt. II. p. 185.

[§] Dev. Brachiopoda, 1863, pp. 46–48, t. VI, figs. 11–17.

From this quotation, and the figures, it will be seen that while there is no doubt that this species is without doubt a *Spirifera* in the broad sense, still there is little probability of it belonging to *Spiriferina*.

Spirifera, *sp. ind.*

(Pl. XVII, fig. 10.)

This specimen is unfortunately but ill-preserved, but gives us evidence of another type of *Spirifera* in this fauna. The hinge line was long, cardinal angles rounded, bead of the brachial valve not very prominent, crural processes not very large, long, but not very prominent, median septum present; median fold well-developed, bearing about ten small thin ribs. Surface ornamented with numerous primary and secondary ribs which are not prominent. There is also evidence of four concentric growth lines.

The specimen is too imperfect to enable satisfactory comparisons to be made. The most salient point in its structure appears to be the great development of the median septum in the dorsal, a structure that is generally absent in *Spirifera*.

Genus.—ATHYRIS, *McCoy*, 1844.

(Synop. Carb. Foss. Ireland, p. 128.)

Athyris, *sp. ind.*

(Pl. XVII, fig. 6.)

This appears to me to be referable to *Athyris*. The specimen represents the cast of a brachial valve, showing the impression of the well-developed median septum or ridge. The shell was a little broader than long, the cardinal angles well rounded, the beak not prominent, and the valve ornamented with well-developed concentric growth ridges. The fold is not very strongly marked.

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[*] Dev. Brachiopoda, 1863, pp. 46-48, t. 6, figs. 11-17.

[†] Pal. N. York, 1894, VIII, Pt. 2, pp. 53-54.

To *A. concentrica*, Von Buch, as figured by Davidson,* there is some resemblance, and though it does not correspond with any of the forms figured by that author, there is a probability of our specimen being a variety of that Devonian species.

Brachiopoda, *ind.*

I have been much puzzled with the original of Pl. XVII, Fig. 7. It is beyond doubt a Brachiopod, and one of the curved hinge-line forms. The attachment scars of the two large divaricator muscles are very large and elongate-ovate, separating the greater portion of them is a ridge continued from the lower extremity of the smaller adductor area. There is no well-marked ridge marking the boundary of the divaricator muscles, they being attached to a gradually deepening space. There were evidently two diverging dental plates. The valve at the apical portion must have been very thick at the sides, attaining a thickness of a fifth of an inch. The remainder of the shell was rather thin, and ornamented with a large number of radiating costæ. The sinus was small, the area high.

There is a possibility of this being one of the Atrypidæ, and perhaps even *Atrypa*, with which it has a great deal in common in the arrangement of the muscle scars. On the other hand, there is a great difference in the thickness of the sides and the greater development of the beak in the White Cliffs specimen, and also in the presence of the ridge between the divaricator muscle scars—an item that is wanting in *Atrypa*. There is also resemblance to the *Rhynchonellidæ*, with which it agrees in the possession of this ridge, but differs from in the relative position of the muscle scars.

PELECYPODA.

Genus.—ACTINOPTERIA, *J. Hall*, 1883.

(Pal. N. York, V, Pt. 1, 1884, p. 12 ; Plates and Explanations, 1883, pl. XXV, fig. 1.)

Actinopteria australis, *sp. nov.*

(Pl. XVIII, figs. 14, 15.)

Left valve of moderate size, slightly oblique, convex, longer than broad. Umbo apparently not very marked (it has been broken off in the specimens) and anterior, shell gradually convex from the umbo to the border. Hinge-line straight, about one-sixth less than the length of the shell, extending probably in perfect specimens a little beyond the posterior margin. The beak is imperfect, but judging by what remains was most likely acute and directed forward and almost terminal, anterior. The anterior ear is also wanting, but must have been small; while the posterior ear or wing is large, triangular, excavate, with a strongly concave margin and an acute extremity. The wing is almost flat, and separated from the convex umbonal portion by a much more gradual convexity. The shell was thin and ornamented with both concentric growth lines, the general direction of which is shown in Pl. XVIII, Fig. 15, while in Fig. 14 are shown the radiating ribs. These are fairly close, and appear to be to a slight extent alternately larger and smaller; the larger ones —the primary—extend to the umbonal region, but owing to the indistinct mode of preservation it is impossible to trace the secondary ribs. No trace of ribs can be seen on the ears as preserved.

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* Brit. Foss. Brach., III, pl. III, figs. 11-15.

Length	42	millimetres.
Width	32	„
Hinge-line	37	„
Depth of valve	6	„

There can be no doubt that this shell is one of the Aviculoid shells, and as far as one can judge from its appearance, in the absence of internal structure, and its association, may be classed under Hall's genus, which was formed for *Pterinea*-like shells without "a broad striated ligamental area and strong cardinal and lateral teeth." It is also like, in outline, some species of the same Author's *Leiopteria* which differs from *Actinopteria* in outward characters, mainly in the absence of radiating ribs. Compare for instance *Leiopteria Conradi*, Hall,* which is a little more oblique and relatively transverse than our species. It is much less oblique and relative transverse than the American Devonian species figured by Professor Hall, and these points, together with the greater extension of the hinge-portion of the wing, will easily separate it from *A. muricata*, *Doris*, *subdecussata*, *decussata*, *Boydii*, *perobliqua*. To Mr. Whidborne's *A placida*† there is also some resemblance, but the Australian form is less transverse and oblique, and the anterior ear appears to have been much less developed.

Genus.—LYRIOPECTEN, *Hall*, 1883.

(Pal. N. York, 1884, V, Pt. 1, p. 12; M.S., *op. cit.*, 1877, V, *Fide* Miller, N. Am. Pal.)

Lyriopecten gracilis, *sp. nov.*

(Pl. XVIII, fig. 8.)

Left valve of moderate size, regular, gently convex, wider than long, hinge-line much shorter than the width of the shell, anterior ear small, almost rectangular, with slightly concave margin, clearly marked off from the anterior umbonal slope, not ornamented with ridges only with growth lines. Posterior expansion larger, not quite so sharply marked off from the posterior umbonal slope as imperfectly preserved, but not so concave in its posterior margin, umbo not prominent. Shell on the whole shallow, surface ornamented with numerous fine radiating ridges, of alternating thickness, which appear to be primary and secondary, the last mentioned arising at about a third the distance from the umbo and running to the margin, increasing slightly in size; no traces of concentric growth lines are preserved.

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* Pal. N. York, 1884, V. 1, Pt. 1, t. 20, f. 4.

† Dev. Fauna S. England, 1892, II, Pt. 2, p. 67, t. 7, f. 9.

Length	23	mm.
Width	27	„
Hinge-line	13	„
Anterior ear, length	6·5	„

Professor James Hall instituted the genus *Lyriopecten* for forms generally similar to ***Aviculopecten***, but differing from it "in the short hinge-line and very small anterior ears. Test usually ornamented with strong rays." This shell is unfortunately imperfect, but enough remains to enable comparisons to be made with already described forms. Our species differs from the American Devonian forms in its smaller size, less prominence of ribbing, and lesser degree of obliquity.

Genus.—PTERINEA, *Goldfuss*, 1826.

Pterinea?

(P.P. XVIII, fig. 4)

It is possible that this may represent part of a small species of *Pterinea*, with very prominent costæ, more cannot be said.

Genus—LEPTODESMA, *Hall*, 1883.

(Pal. N. York, V, Pt. 1, Plates and Explanations, pl. XVII, fig. 12; *op. cit.* [1884], pp. xii, 175.)

Leptodesma inflatum, *sp. nov.*

(Pl. XVIII, fig. 3, and ? fig. 6.)

Shell small, very deep, rhomboidal, oblique, umbonal region high, anterior and posterior sides almost parallel. Hinge-line straight, but little greater than the width of the shell. Left valve only known, strongly convex. Beak small, directed forwards, at about anterior third of the hinge-line. Anterior umbonal slope steep, separated from the anterior expansion by a gradual concavity. Anterior expansion small, blunt (this is too strongly accentuated in Fig. 3), being of moderate size, extending to the posterior extremity, margin straight; posterior umbonal slope less marked than in the case of the anterior, gradually concave. Surface ornamented with a few indistinct concentric growth lines.

Length	21	mm.
Width	15	„
Length of hinge-line	15	„
Depth	9·5	„

L. inflatum appears to be easily distinguished from most of its congeners by its more elongate oblique form and much greater depth of shell and non-extension to the slightest degree of the posterior extremity of the hinge-line. There is a slight general resemblance to *L. Orodes*, Hall* but it differs from the American form in the lesser obliquity and much greater depth. In America the genus is very common in the Chemung Group.

Pl. XVIII. fig. 6 represents, I think, a younger form of the same species.

Leptodesma obesum, *sp. nov.*

This species may be distinguished from *L. inflatum* by the much greater development of the umbonal region, greater inflation and prolongation of the beak, general lesser obliquity and tendency towards squareness of the shell. The anterior ear is smaller and more inflated. The posterior wing is small, not so flattened as in the preceding species, and the posterior margin not marked off in outline from the general convexity of the posterior margin.

Length	... ...	18 mm.
Width	... ...	16 „
Hinge-line	... ...	16·5 „
Depth	... ...	7 „

Genus—ORTHONOTA, *Conrad*, 1841.

(Ann. Rept. N. York Geol. Survey, p. 51.)

Orthonota, *sp.*

(Pl. XVIII, fig. 2.)

This small species, though unfortunately too imperfect to enable one to say so definitely, appears to be different from any hitherto described *Orthonota*, using the term in its broadest sense. It is remarkable for the very marked ridge bounding the posterior umbonal slope. This ridge is very acute and almost a sigmoidal trend. There appears to be no ridging on the posterior umbonal slope. There is a slight constriction of the basal margin formed by a not prominent cincture.

Length	... ...	29 mm.
Height	... ...	6 „

Genus—GRAMMYSIA, *De Verneuil*, 1847.

(Bull. Soc. Geol. France, IV (2), p. 696.)

Grammysia, *sp. ind.*

(Pl. XVIII, fig. 1.)

It is possible that the imperfect specimen represented by this figure may be one of the very slender *Grammysia*. There are evidences of a well-marked plain cincture, forming a very marked constriction in the basal margin.

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* *Op. cit.*, 1884, p. 206, t. 25 f. 6, 9, t. 90, f. 8.

Pelecypoda, *gen. ind.*

Of these two fossils shown in Plate XVIII, figs. 5 and 7, nothing can be said. There is absolutely no trace of the hinge structure preserved. Figure 7 may be a *Myophoria*, and perhaps fig. 5 may be considered for the time being as one of the very large group of Palæozoic bivalves classed under *Cucullæa*, which has been used as a resting place for numerous ill-preserved arcoid shells of uncertain affinities.

GASTEROPODA.

Genus—MURCHISONIA, *D'Archiac and De Verneuil*, 1841.

(Bull. Soc. Geol. France, XII, p. 154.)

Murchisonia, *sp. ind.*

(Pl. XVIII, fig. 11.)

The impression of a portion of a turreted gasteropod, showing indistinct traces of the band, is also found at this locality. Parts of five whorls, having a height, as preserved, of nearly 1¼ inch, are shown; the whorls are regularly convex, the band does not appear to have been prominent, the sutures are well marked, and the angle of inclination of the sides is about 14°.

Genus—LOXONEMA, *Phillips*, 1841.

(Pal. Foss. Devon., p. 98.)

Loxonema, *sp. ind.*

There is also in the collection a cast of a small *Loxonema* after the type of *L. trochleatum*, Munster,[*] on a large scale; its whorls have a height of—body whorl, of 6·5 mm.; second last, 4 mm.; and last four whorls, a quarter of an inch. These whorls are squarish, not very convex, suture slightly marked, and the angle of inclination of the sides about 10.° De Koninck records a *Loxonema* from the Yass District that he identifies with the European species[†] *L. antiquum* also of Münster, and as a synonym of it gives *L. subulata*, Roemer,[‡] and also of Sandberger.[§] Mr. Whidborne[‖] refers to these two author's species as being synonymous with *L. trochleatum* Münster. From what little is preserved our specimen agrees very closely with that Author's figures in all except size and slight difference in inclination of the sides. The White Cliffs specimen evidently decreases in width more rapidly than *trochleatum*; in De Koninck's figure of *antiquum*, the apical angle is said to be 5°; in this form it appears to be nearer 10°. The whorls are much more perpendicular to the axis than in De Koninck's Fig. 10, approaching more to that of his Fig. 10A, and again less square than in Mr. Whidborne's figures. There appears to be no trace of the "flat rim under the suture" mentioned by that Author as occurring in the English form. The surface appears to have been smooth.

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[*] Beitrage zur Petrefactenkunde, 1840, III, p. 88, t. 15, fig. 16.

[†] Pal. Foss. N. Galles du Sud, 1878, p. 125, t. 4, f. 10.

[‡] Versteinerungen Harzgebirges, 1843, p. 31, t. 8, f. 12, 12A.

[§] Versteinerungen Rhein. Sch. systems Nassau, 1850, p. 229, t. 26, f. 10.

[‖] Mon. Dev. Fauna S. England, 1886, III, Pt. 1, p. 41, t. 5, f. 4-5A.

Genus—EUOMPHALUS, *J. Sowerby*, 1814.

(Min. Conch., I, p. 97.)

Euomphalus Culleni, *sp. nov.*

(Pl. XVIII, figs. 12, 13.)

Shell of moderate size, conical, depressed, three whorls, but little elevated beyond the body whorl; decrease of whorls in size gradual, upper angle convex, evidences of a faint shoulder near the suture, which was not deep; lower angle of body whorl more convex than the upper.

Height	11 mm.
„ of body whorl	8 „
Diameter...	17 „

The tapering of the shell is rapid and regular; the basal portion of the shell appears to have been strongly concave.

I know no species with which I can compare this, except *E. vermis*, Whidborne,* from the Devonian of the South of England, than which it is much larger. In *E. vermis*, which is very minute, the whorls have a squarer appearance, and the body whorl is relatively larger than in our species. Compare also *Straparollus mopsus*, Hall, from the Niagara group of North America.†

Genus.—TENTACULITES, *Schlotheim.*

(Petrefactenkunde, 1820, p. 377.)

Tentaculites *cf.* bellulus, *Hall.*

(Pl. XVIII, figs. 9, 10.)

Numerous fragments of *Tentaculites* occur in the White Cliffs quartzite. The form is long, slender, gradually tapering. Annulations thick, obtuse, less in width than the spaces separating them, about three to a millimetre, closer together towards the apex, where they are much less marked. There appears to be little or no trace of transverse striation between the annulations. The enlargement figured in Pl. XVIII, Fig. 9, may possibly represent another species; in this the annulations are arranged in sets of three, with a wider space between them.

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* Dev. Fauna S. of England, 1896, III, Pt. 1, p. 52, t. 5, f. 4–4A.

† Rept. State Cab. Nat. Hist. N. York State, 1867, XX, p. 342, t. 15, f. 21, 22.

None of the shell is preserved, so that its affinities are doubtful. It appears to me to be close to *T. bellulus*, Hall,[*] from the Hamilton Series. None of the forms figured by Barrande[†] resemble it very closely. There is also some general resemblance to *T. ornatus*, Sowerby.

Mr. R. Etheridge, junr., has described[‡] a *Tentaculites* from the limestone of Wellington, New South Wales, for which he suggests the name *T. Liversidgei*, should further investigation prove it to be new. This appears to be larger and the annulations more acute than in the White Cliffs species.

Genus.—ORTHOCERAS, *Breynius*, 1732.

(Dissert de Polythal, pp. 12, 25.)

Orthoceras, *sp.*

(Pl. XVII, fig. 8.)

Two specimens, very imperfect, of an indeterminable *Orthoceras* occur in the collection. One of these, figured in Pl. XVII, Fig. 8, shows the traces of four septa. The width of the cast of the shell is 21 millimetres, the distance between the septa about 5 mm., and the angle of inclination of the sides about 6° 30′; shell evidently very long, straight, septa slightly inclined.

A form, either the same or else closely allied to this, occurs in several of the Palæozoic sandstones of the Western District. In its imperfect state it is impossible to institute comparison with any of the hitherto described species. There may be some relation to *O. procerus*, Hall, from the Devonian of the United States.[§]

Genus.—GONIATITES, *De Haan*, 1825.

(Mon. Ammon et Goniatites, p. 39.)

Goniatites, *sp. ind.*

(Pl. XVIII, fig. 16.)

What is taken to be the dorsal portion of a *Goniatites* is represented in Pl. XVIII, Fig. 16. It cannot be freed from the matrix. The contour, viewed from the dorsal side, appears to have been very triangular, and the width, judging from the specimen as preserved, a little greater than the length, nearly a quarter of an inch. No trace of the sutures is preserved, so that it is impossible to say under which of the sections of *Goniatites* it should rest.

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[*] Pal. N. York, 1879, V, Pt. 2, p. 169, t. 31, f. 15–18, t. 31 A, f. 48–51.

[†] Syst. Sil. Boheme, III.

[‡] Journ. R. Soc. N. S. Wales, 1880 [1881], XIV, p. 253, pl. , figs. 10, 10a.

[§] Pal. N. York, 1879, V, Pt. 2, p. 249, t. 35, f. 15; t. 79, fig. 5.

XXV.—Palæontologia Novæ Cambriæ Meridionalis.—Occasional Descriptions of New South Wales Fossils, No. 3: by R. ETHERIDGE, Junr., Curator of the Australian Museum, Sydney.

(*Continued from Vol.* V, *Pt.* 1, *p.* 18.)

[Plate XIX.]

1.—*Generic Position of* Rhynchonella inversa, *De Koninck.*

Pl. XIX, Figs. 1–13.

IN his work on the Palæozoic Fossils of New South Wales, the late Prof. L. G. de Koninck described a Permo-Carboniferous Brachiopod under the above name.*

He may possibly have been led to place his species in this genus from its general resemblance to the *Rhynchonella angulata*, Linn., as he instituted a comparison between the two forms. The specific description of *R. inversa* was very clearly and correctly given; but it seems to me that De Koninck's conception of its generic affinity, and his reading of the relative positions of the fold and sinus,† was erroneous. The chief point of interest about this species lay in the transfer of the dorsal fold to the ventral valve, and of the ventral sulcus to the dorsal valve. To my mind there is nothing abnormal in the structure of these portions of *R. inversa*, the "sinus médian assez profond" of the dorsal valve being simply a sinus in the centre of the fold, which is represented by "un pli" on each side; whilst the "pli médian" of the ventral valve is nothing more than a fold in the sinus of the latter, the "deux autres plis oblique" being the lateral boundaries of the sinus proper. This condition, varying only in degree, is to be seen in many Brachiopoda—for instance, the Cretaceous *Terebratula biplicata*, Brocchi; the Cornbrash, *T. Bentleyi*, Morris; some forms of the Carboniferous *Dielasma hastata*, Sby.; the Lower Silurian *Orthis insularis*, Eichwald, and others. *Rhynchonella inversa* is, in truth, merely an abnormal *Dielasma.*

Some internal casts of the dorsal valve exhibit the small but well-developed lozenge-shaped muscular platform characteristic of *Dielasma*, and it is to this genus that I propose to transfer De Koninck's species. It is not visible in all specimens of the dorsal valve, but I have been fortunate enough to obtain a satisfactory wax relief (Pl. XIX, Fig. 11), taken from a good internal cast (Pl. XIX, Fig. 10), that shows the platform excellently. In all, the cavities left by the dental plates of the ventral valve, and the edges of the dental sockets in the dorsal valve, are visible—portions that seem to have been well developed in *D. inversa.* In some examples the short dorsal septum is seen (Pl. XIX, Fig. 5), and in a rather abnormal variety (Pl. XIX, Fig. 8) the fold of the ventral valve is grooved in the cast, representing a ridge in the shell. It has, however, been too forcibly represented in the drawing.

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* Foss. Pal. Nouv.-Galles du Sud, Pt. 3, 1877, p. 220, t. 11, f. 8.
† *Loc. cit.*, p. 221.

D. inversa exhibits some amount of variation in form. De Koninck figured an example broad across the centre of the valves, attenuating rapidly towards the front, and with a high and rather narrow ventral umbo. In Pl, XIX, Figs. 12 and 13 a somewhat similar individual is represented; but in all the other illustrations now given the shell is proportionately shorter from umbo to front and deeper through the valves, whilst another variety (Pl. XIX, Figs. 7–9) is essentially broad across the latter. There is also variation in the sigmoidal curvature of the lateral margins. In De Koninck's Fig. 11A the latter are flexuous; in our Pl. XIX, Fig. 1, they are more strictly sigmoidal; in Pl. XIX, Fig. 4, simply rounded; whilst in Pl. XIX, Fig. 9, although again rounded, the margins of the dorsal valve project backwards, impinging greatly on the capacity of the ventral valve, and with an almost vertical middle line. In fact, this deepening of the sides of the dorsal valve is very much like what takes place in *D. cymbœformis*, Morris;[*] but in this species the fold and sinus are normal in character.

Locality and Hor.—Near Pont's House, between Regent Street Crossing and Maitland Colliery (Pl. XIX, Figs. 4–10, Maitland (*J. Waterhouse, M.A.*); Quarry, about a quarter of a mile north-west of the Waterworks (Pl. XIX, Figs. 12 and 13), West Maitland (*J. Waterhouse, M.A.*).—Upper Marine Series, Permo-Carboniferous. Harper's Hill (Pl. XIX, Figs. 1–3), near West Maitland (*J. Waterhouse, M.A.*)—Lower Marine Series, Permo-Carboniferous.

2.—Platyschisma oculus, *J. de C. Sowerby.*

(Pl. XIX, Figs. 14–17.)

This characteristic Gasteropod of our Lower Marine Series passes through much variation in the height of its spire. The original figure by J. de Carle Sowerby,[†] as *Trochus oculus* represented an individual with a depressed spire, and with the first and second whorls hardly raised above the third in a side view or elevation. As *Platyschisma oculus*, Morris[‡] figured a high shell, with four whorls visible in a similar position; whilst Dana[§] in his splendid work detailing the Geological results of the Wilkes' United States Exploring Expedition, gives an illustration of one, although apparently less in height, still with the four whorls in evidence. Plews,[‖] notwithstanding a rough drawing, illustrates an extremo form in the height of the spire; and lastly De Koninck* in referring the species to *Euomphalus*, whilst figuring the whole four whorls visible in a side view, gives a decidedly less elevated shell than Plews.

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[*] Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, t. 18, f. 1.

[†] Mitchell's Three Exped. Int. E. Australia, 1838, I, p. 15, t. 2, f. 3 and 4.

[‡] Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 286, t. 18, f. 1.

[§] Wilkes U.S. Explor. Exped., X, Geology, 1849, p. 707, t. 10, f. 1.

[‖] Mining Inst. Journ., 1858 VI, Pt. 3, t. 4.

In Pl. XIX, Figs. 14–17, is a very depressed variety that might, under ordinary circumstances, and with justification, be regarded as specifically distinct. It will be observed that instead of four whorls only two are visible in a side view (Pl. XIX, Figs. 14 and 15), the first and second are sunk or depressed below the sutural line of the third, as is so frequently seen in Euomphaloid shells. Between this condition and the high-spired, or what may be called the typical form, every gradation exists.

The present specimen also displays the sculpture in a fine state of preservation, more so than is usually the case. The regularity of the fine, sharp, oblique threads is beautifully retained, as well as the backward flexure over the obtusely angular periphery of the body whorl (Pl. XIX, Fig. 17), but without the faintest trace of a band, or a sinus on the outer lip, in accordance with the generic position of the species. At the same time, on portions of the surface are remarkably fine spiral, and occasionally wavy wrinkles, more particularly on the upper and lower aspects of the body whorl, that under the lens are seen to break it up into a series of minute parallelograms. Of the two, this is even more apparent on the lower surface (Pl. XIX, Fig. 15).

Locality and Hor. Harper's Hill, near West Maitland (*T. Waterhouse, M.A.*)—Lower Marine Series, Permo-Carboniferous.

3.—Actinoconchus planosulcatus, *Phillips, sp.*

(Pl. XIX, Fig. 18.)

On two former occasions I figured spine-bearing examples of an *Athyris* from the Permo-Carboniferous of Queensland. Both were referred to *Athyris Roysii*, Lev.,† or as it must now be called *Cliothyris Roysii*, Lev., sp. Through the light thrown on the matter by the acquisition of the present specimen (Pl. XIX, Fig. 18), I am induced to believe that I was wrong in referring the second of these, that from the Rockhampton District, to *Cliothyris Roysii*. I now consider it to be an example of *Actinoconchus planosulcatus*, and identical with that at present under consideration from New South Wales.

In *A. planosulcatus* the growth lamellæ of the valves are extended as successive semicircular frills, each frill flat and longitudinally striate. A portion of these is seen in the figure of the specimen just referred to, and two portions of another in Pl. XIX, Fig. 18. In neither case are the plates subdivided into separate spines, as in *Cliothyris Roysii*, but are continuous and grooved radiately. The late

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* Foss. Pal. Nouv.-Galles du Sud., Pt. 3, 1877, p. 330, t. 23, f. 18 *a—c*.

† Geol. and Pal. Queensland, 1892, p. 243; Proc. Linn. Soc. N. S. Wales, 1895, IX (2), p 529, t. 39, f. 4.

Dr. Thomas Davidson always spoke of these grooves as striæ, but the acquisition of more perfect examples enabled Messrs. Hall and Clarke* to show that the lamellæ surrounding the shell of *Actinoconchus planosulcatus* consisted of "fine tubular spines connected by, or embedded in a tenuous calcareous plate," or plates. This is entirely borne out by the structure of the present specimen, for on placing it under a moderately high magnifying power it is at once apparent that each of the radii is hollow, and filled now with clear calcite.

Locality and Hor.—Dungog Road, nineteen miles from West Maitland, Parish of Barford, County of Durham (*J Waterhouse, M. A.*)—Carboniferous.

4.—*Genus.*—LEIOPTERIA, *Hall*, 1882.

(35th Ann. Report N. Y. State Cabinet Nat. Hist., p. 406c.)

Leiopteria ? australis, sp. nov.

(Pl. XIX, Fig. 19.)

Sp. Char.—Shell sub-rhomboidal, oblique, longer than wide, produced postero-ventrally. Hinge-line straight, less than the width of the shell; ligamental area narrow. Left valve feebly convex in the umbonal region, the latter subtending an acute angle, the surface becoming much flattened towards the ventral margin, which is obliquely rounded. Anterior end or ear, small, limited by a very undefined sulcus; anterior margin oblique, insinuated in the middle, thence broadly curving to the ventral margin. Posterior end, or wing, triangular, flattened, the extremity pointed; posterior margin more or less sigmoidal; posterior ridge obtuse; sculpture not preserved, but no trace of radii.

Obs.—The specimen figured is an internal cast of the left valve, and does not appear to be specifically related to any previously described Australian Palæozoic shell. It is quite distinct from Dana's *Cypricardia acutifrons*†, although the latter may possibly be generically related. It is almost superfluous to say that Dana's species is not a *Cypricardia.*

Locality and Hor.—Dungog Road, nineteen miles from West Maitland, Parish of Barford, County of Durham (*J. Waterhouse*, M.A.).—Carboniferous.

5.—*Genus.*—LEPTODOMUS, *McCoy*, 1852.‡

(Brit. Pal. Foss., 1852, Fas. 2, p. 277.)

Leptodomus duplicicosta, sp. nov.

(Pl. XIX, Figs. 20 and 21.)

Sp. Char.—Shell transversely oblong; valves moderately convex, most so at about half the distance between the anterior and posterior margins. Hinge-line, or dorsal margin, straight; ventral margins gently convex, the curvature only faintly interrupted by the cinctures; anterior margins rounded; posterior margins rounded below, rather obliquely truncated above. Diagonal ridges obtusely rounded; posterior slopes convex anteriorly, concave posteriorly, with a shallow median groove; cinctures shallow and faint, and without a succeeding fold; lunule apparently small and inconspicuous; umbones depressed and incurved. Sculpture very characteristic, and strongly marked, consisting of coarse strong costæ, simple anteriorly, and as far as a point in a line with the umbones, from this point widely bifurcate, and on passing over the diagonal ridges seem to have been somewhat echinate; intervening valleys shallow.

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* 13th Ann. Report State Geol. N. York for 1893 [1894], II, p. 780.
† Wilkes' U.S. Explor. Exped., X, Geology, 1849, t. 8, f. 4, A and B
‡ Non *Leptodomus*, McCoy, 1844.

Obs.—This little shell is remarkable not only for the strength and paucity of its concentric costæ, but also for the remarkably strong bifurcation of the latter. Succeeding costæ may be bifurcate, or every alternate one, or only every third costa. Traces of an epidermis are visible on one portion of the specimen. *L. duplicicosta* possesses somewhat the appearance of two shells called by De Koninck *Palæarca interrupta*,* and *P. subarguta*,† but is distinguished by the characters already given.

Locality and Hor.—Maitland Colliery Shaft, near West Maitland (*J. Waterhouse* M.A.).—In hard nodules of the Upper Marine Series, Permo-Carboniferous, sixty to ninety feet from the surface.

XXVI.—Stratigraphical and Palæontological Notes, No. 1: by W. S. Dun, Assistant Palæontologist.

I.—*Devonian Fossiliferous Beds at Eden.*

I AM indebted to Mr. J. E. Carne for the following notes on the occurrence and discovery of Devonian fossils in the sandstones at Bell Bird Creek, three miles north of Eden. Shells were first noticed by J. Hall while quarrying road-metal at the above-mentioned locality, on the Pambula Road. One of these shells was forwarded to Mr. Carne, at that time engaged on the Border Prospecting Survey at Delegate, and others were afterwards collected by one of the Prospecting Party. In August Mr. Carne visited the locality, and collected a number of specimens, among which were undoubted *Rhynchonella pleurodon*, Phillips; also a large species of *Rhynchonella*, imperfect, with very strongly marked ribs. This is very close to *R. cuboides*, Sby., a common European Devonian species, though, on the other hand, there is a possibility of its being one of the extreme variations of *R. pleurodon*. There are also a few imperfect specimens of *Atrypa*, very like some small forms of *A. reticularis*, Linn. Indefinite traces of a small branching Polyzoan are also present.

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* Foss. Pal. Nouv.-Galles du Sud., Pt. 3, 1877, p. 287, t. 16, f. 5,

† *Ibid.*, p. 287, t. 16, f. 8.

The fossils occur in a much indurated, in places felspathic, sandstone, which is very hard, and varies from a fine grained to a coarse grit. From its position it must form one of the lower members of the Devonian series, overlying the Upper Silurian (?) rocks of the district. These Devonian sandstones and conglomerates alternate with very ferruginous roughly cleaved clay-slates, which, from their distinctive red and purple colouring, form a very marked surface feature. Close search has yielded no trace of organisms in the last-mentioned beds.

The fossiliferous sandstone has a dip of N 61° E, at an angle of 15°, and a strike of N. 29° W. The bed is characterised by ripple marks and annelid markings, and is probably of shallow water deposition.

This is the first occasion on which the age of these beds has been decided on palæontological evidence. A detailed account of the general geology of the Eden District will be found in a Report by Mr. Carne.[*] These beds were classed as Devonian by the Rev. W. B. Clarke.[†] Mr. E. F. Pittman,[‡] in a report on the District in 1880, states that he was of opinion from their lithological character that the more horizontally-bedded deposits might be either of Triassic age, or similar to the Devonian of North Gippsland; the resemblance to Triassic sandstones was also noted by Mr. Clarke. The lower series Mr. Pittman classed as Silurian. Mr. W. Anderson[§] classed the whole series, with the exception of a conglomerate bed at the top—which he considered to be Devonian—as Silurian. Mr. Carne's observations bear out the view that at Eden the lower beds are Silurian, and the more horizontal sandstones, conglomerates, and slates as Devonian.

II.—Permo-Carboniferous beds in the Kempsey District.

In 1892, Mr. E. W. Rudder submitted to the Department some Permo-Carboniferous fossils from a locality six miles west of Kempsey. These were:—

Spirifera.
Fenestella.
Deltopecten cf. illawarrensis, *Morris.*
Trachypora Wilkinsoni, *Eth. fil.*

In 1896 Mr. J. E. Carne collected a few specimens from Ph. Willi Willi, Co. Dudley, and Mr. C. Cullen shortly after collected from this Parish, and also from Ph. Warbro, a large number of undoubted Permo-Carboniferous forms. These were preserved mostly in limestone of which there appears to be considerable development, both in thickness and area, and also in associated shales. This is as far as I am aware the first recorded instance of large deposits of Permo-carboniferous limestone in New South Wales, though limestones are well-developed in the underlying Carboniferous Beds. The limestone fauna comprises :—

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[*] Ann. Rept. Dept. Mines and Agric. N. S. Wales for 1896 [1897], pp. 100–112.
[†] Southern Gold-fields, 1860, pp. 191–194.
[‡] Ann. Rept. Dept. Mines for 1880 [1881], p. 244.
[§] Ann. Rept. Dept. Mines N. S. Wales for 1890 [1891], p. 263.

Spongida.—Traces of a sponge, preserved as casts of elongated simple spicules, possibly *Lasiocladia.*

There are also some long isolated simple spicules that may be the anchoring spicules of *Hyalostelia.*

Cœlenterata.—Zaphrentis gregoriana, *De Kon.*
Zaphrentis, sp.

There are also numerous casts of a very ramose coral which appears to be a stout variety of *Cladochonus tenuicollis,* McCoy. *Stenopora tasmaniensis,* Lonsdale (?).—Some small casts of a Monticuliporoid are taken to be a small variety of this species. There is also a larger species in which the corallites are arranged very obliquely along the central axis.

Polyzoa.—Fenestella internata, *Lonsdale.*
„ fossula, *Lonsdale.*
„ propinqua, *McCoy* (?).
Protoretepora ampla *DeKoninck.*
Phyllopora (cf. Retepora ? laxa, *DeKoninck.*)

Brachiopoda.—Martiniopsis subradiata, *Sby.*
„ oviformis, *McCoy* (?).
Spirifera tasmaniensis, *G. Sby.*
„ vespertilio, *G. Sby.*
„ sp ?
Productus semireticulatus, *Martin* (?).
„ brachythærus, *G. Sby.*
„ cf. undatus, *Defrance.*
Strophalosia, sp. indet.

Pelecypoda.—Eurydesma cordata, *Morris.*
Deltopecten illawarensis, *Morris.*
Aviculopecten squamuliferus, *Morris.*

From this list it will be seen that taking all the species into consideration there can be no doubt that the facies is Permo-Carboniferous. On the other hand, there is also a mixture of Carboniferous forms with the others. It is impossible to say at present whether these beds belong to the Upper or Lower Marine Group, though I think there is a great probability of their being eventually proved to be Lower.

In the various geological maps of the Colony there have been several changes in the correlation of the formations in this district. In that published in 1880, issued by the late C. S. Wilkinson, and compiled from the Rev. W. B. Clarke's original map, the country immediately around Kempsey is coloured as Devonian. A strip of this extends for about twenty miles to the north and five to the south, along the western portion of this is marked a bed of limestone nearly twenty miles long and presumably Devonian also. (Part of this is probably the area under discussion in this note.) On either side of the Devonian area upper Silurian deposits are shown extending for a considerable distance to the north; a patch of granite bounds it on the north, Coal Measures on the south, and there are patches of basaltic rocks on either side. This disposition of formations is retained in the geological map issued in the 1882 edition of the " Mineral Products."

On the map issued by the same authority in the second edition of the " Mineral Products," published in 1887, the sole change is that the Upper Silurian deposits shown on the 1880 and 1882 maps are mapped as Devonian.

In the latest geological map of the Colony, that published under the direction of Mr. E. F. Pittman in 1892, this same tract of country is coloured as Upper Silurian.

De Koninck* describes from this district the following fossils, which he classes as Devonian :—

Favosites polymorpha, *Goldf.*
Strophalosia productoides, *Murchison.*
Chonetes hardrensis, *Phillips.*
„ coronata, *Conrad.*
Atrypa reticularis, *Linn.*
Aviculopecten Etheridgei, *De Koninck.*
„ McLeayi, *De Koninck.*

These specimens, collected about forty years ago by the Rev. W. B. Clarke, were unfortunately destroyed by fire in the Garden Palace fire in 1882. From this district there are at present no specimens from either Devonian or Silurian beds in the collections, the nearest Devonian area represented by fossils being on the Pigma Barney River, near its junction with the Manning, whence Mr. G. A. Stonier collected specimens of *Favosites*. Mr. Carne informs me that he is of opinion that the Willi Willi and Warbro beds rest unconformably on an older series consisting of highly-inclined slates, which are either Upper Silurian or Devonian. Up to the present, as far as I am aware, no fossils have been found in these slates, so that their correlation is based on lithological evidence only.

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* Foss. Pal. N. Galles du Sud, 1876, II., pp. 79, 83, 85, 87, 97, 114.

III.—The Occurrence of Graptolites in the Peak Hill District.

The Mining and Geological Museum is indebted to Mr. F. Danvers Power for several specimens of a bluish grey lustrous slate, showing numerous graptolites, from Myall Reefs, near Tomingley, in the Peak Hill District. These are much distorted and preserved as white films, with the outlines of the hydrothecæ preserved but in rare instances. Some of them are undoubtedly Diprionidian forms, though some may be imperfectly preserved Monoprionidians. These slates, up to the present considered to be barren, have been mapped as Upper Silurian, and unfortunately the fossil evidence is too unsatisfactory to enable the matter to be settled definitely as yet, as *Diplograptus* forms occur in both Lower and Upper Silurian rocks, though more characteristic of the former. Upper Silurian Graptolites have been found in New South Wales at Bowning, by Mr. John Mitchell.* The Rev. W. B. Clarke also remarks† that "one is said to have been found in this Colony, and I presume it is more likely to belong to the Upper Silurian than to the Lower"; but does not mention the locality of the occurence.

Additional specimens obtained by Messrs. Power and Card, while this was going through the Press, prove beyond doubt that these slates contain Graptolites of a Lower Silurian facies, *Climacograptus* and *Dicellograptus.*

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BALFOUR (L.)—*Vide* OFFICER (G.)

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Correction.

Record for 1895.

P. 90, line 15, for X read IX.

XXVIII—Kalgoorlite—a new Telluride Mineral from Western Australia: by E. F. PITTMAN, A.R.S.M., Government Geologist.

DURING an official visit to Western Australia in October last I had an opportunity of examining the rich telluride deposits of Kalgoorlie. These occur as intrusive dykes of a very crushed and foliated or schistose igneous rock, which has been examined in thin sections under the microscope by Mr. G. W. Card, A.R.S.M., Mineralogist to the Geological Survey, and has been described by him as a quartz-felspar-porphyry. The telluride minerals occur as veins, splashes, and pockets in this rock, and have evidently been deposited in the spaces between the folia by ascending solutions.

Amongst the tellurium minerals occurring in these mines, at least two distinct varieties were conspicuous at the time of my inspection. One of these minerals was of a dark—almost black colour, and in this respect offered a strong contrast to the other which was of a pale yellow. It was a matter of difficulty to obtain a sufficient quantity of either mineral in a state of purity to enable a complete analysis to be made, but I am indebted to W. F. Grace, Esq., Manager of the Lake View and Boulder Junction G. M. Co., for a small sample (slightly over one gramme) of each.

-16-1918

The dark mineral has a specific gravity of 8·791. It is massive, and has a sub conchoidal fracture. Colour, iron black.

A quantitative analysis was made by Mr. J. C. H. Mingaye, F.C.S., Analyst to the Geological Survey of N.S.W., and yielded as follows :—

Mercury	10·86	
Gold	20·72	
Silver	30·98	
Copper	·05	
Sulphur	·13	
Tellurium	37·26	(by difference).
	100·00	

It is clear from Mr. Mingaye's analysis that the composition is different from that of any mineral hitherto recorded. The empirical formula calculated from the above figures is $Hg. Au_2. Ag_6. Te_6$. I propose to name the mineral "*Kalgoorlite*," after the celebrated gold-field in which it occurs.

It is stated that a specimen of native amalgam was found in the Boulder Perseverance Mine, Kalgoorlie, last year, and it is probable that it was derived from the decomposition of this mineral, Kalgoorlite.

An analysis of the pale yellow mineral was also made for me by Mr. J. C. H. Mingaye, with the following results :—

Gold	=	41·76	
Silver	=	·80	Specific gravity.
Tellurium	=	56·65	9·377
		99·20	

The substance is therefore identical with *Calaverite*, the percentage of silver being rather less than that hitherto recorded for this mineral. The specific gravity is also correspondingly higher, as might be expected. It would appear therefore that calaverite may be regarded as a telluride of gold with a variable proportion of telluride of silver.

PLATE XVI.

Syringopora bellensis, *Eth. fil.*

Fig. 1. The corallum, showing the mouths of the corallites protruding through the connecting floors at more than one level.

Fig. 2. Nine corallites, surrounded by the youngest connecting floor. x 1½.

Fig. 3. Two corallites, with the inwardly bevelled margins, forming vestibules as it were. x 4.

Fig. 4. Three corallites, seen in elevation and partial section, showing the rows of spiniform septa. x 2½.

Fig. 5. Two corallites, seen from the outside, also in elevation, with a side view of one connecting floor. x 2.

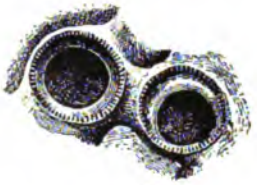
Fig. 6. Horizontal section of two ill-defined corallites, exhibiting the concentric cut edges of the infundibuliform tabulæ. x 10.

Fig. 7. Vertical section of parts of five corallites, showing the infundibuliform tabulæ, the endothecal tissue in the interiors of the connecting floors, and the interstitial free spaces between the latter. In the central long corallite is visible the cylindrical tube with its concave septa. x 3.

Fig. 8. The tabulate portion of the cylindrical tube seen in Fig. 7. x 12.

Fig. 9. Portion of a corallite in vertical section exhibiting the bending down of the infundibuliform septa to form the cylindrical tube. x 4.

Drawn from nature by Mr. F. R. Leggatt.



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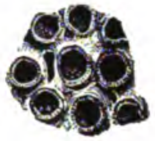

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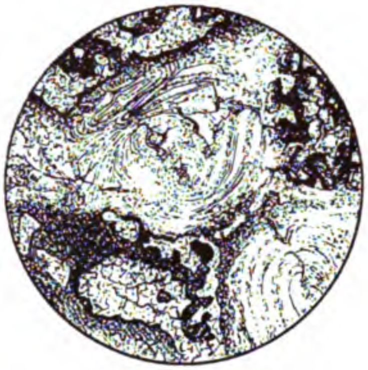

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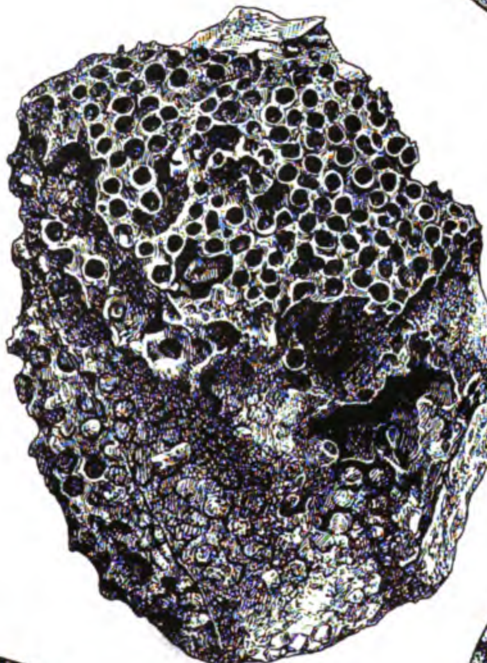

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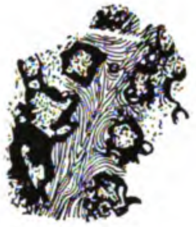

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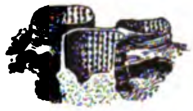

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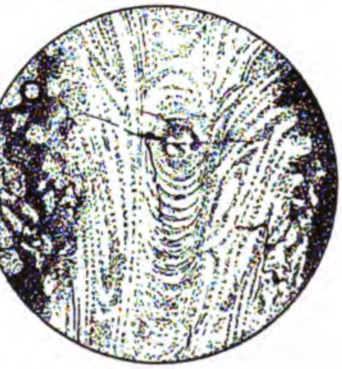

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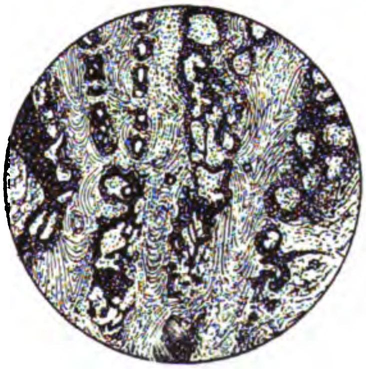

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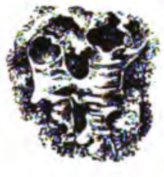

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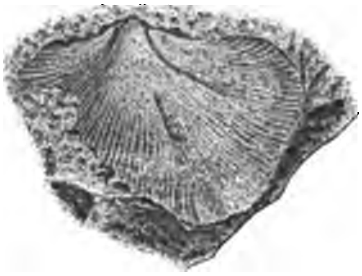
PLATE XVII.

Fig. 1. *Schizophoria*, sp. ind.
Figs. 2, 12, 13, 14, 17. *Spirifera Jaqueti*, Dun.
Figs. 3, 5. *Schizophoria convexa*, Dun.
Fig. 4. *Rhynchonella*, sp. ind.
Fig. 6. *Athyris*, sp. ind.
Fig. 7. *Rhynchonella* (?).
Fig. 8. *Orthoceras*, sp. ind.
Fig. 9. *Pentamerus* (?).
Fig. 10. *Spirifera*, sp. ind.
Fig. 11. *Leptæna rhomboidalis*, Wilck (?).
Fig. 15. *Chonetes*, sp. ind.
Fig. 16. *Rhynchonella pleurodon*, Phillips.

All from the White Cliffs Opal Fields. Drawn from nature by Mr. F. R. Leggatt.
Of natural size.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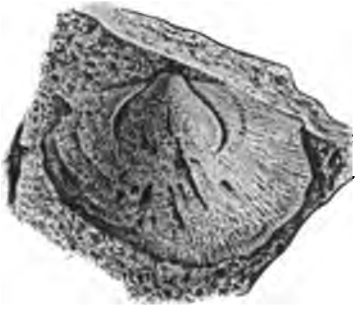
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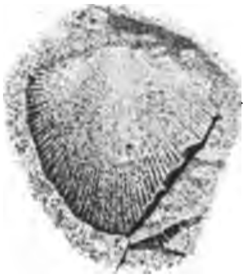
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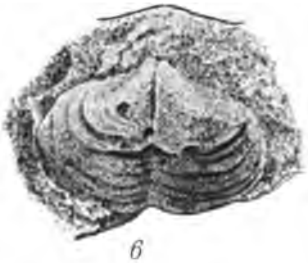
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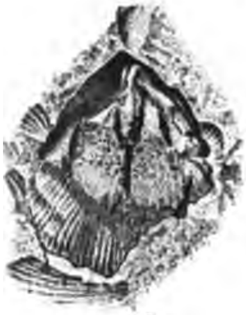
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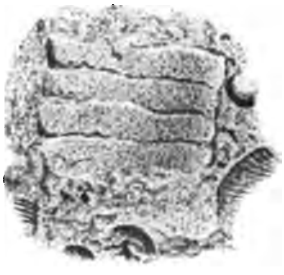
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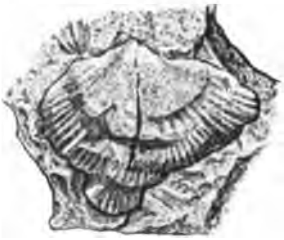
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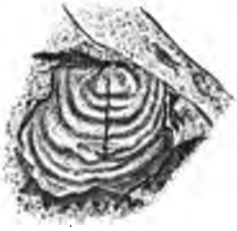
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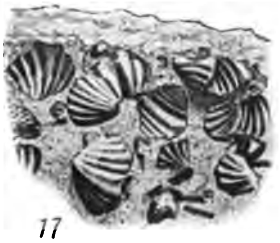
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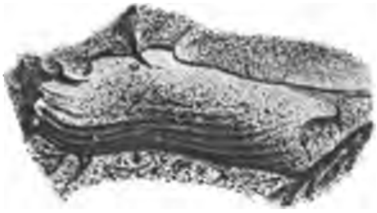
PLATE XVIII.

Fig. 1. *Grammysia*, sp. ind.
Fig. 2. *Orthonota*, sp.
Fig. 3. (Fig. 6 ?) *Leptodesma inflatuia*, Dun.
Fig. 4. *Pterinea* (?).
Figs. 5, 7. Gen. et. sp. indet.
Fig. 8. *Lyriopecten gracilis*, Dun.
Figs. 9, 10. *Tentaculites*, sp. ind.
Fig. 11. *Murchisonia*, sp. ind.
Figs. 12, 13. *Euomphalus Culleni*, Dun.
Figs. 14, 15. *Actinopteria* australis, Dun.
Fig. 16. *Goniatites*, sp. ind.

All these specimens are from the White Cliffs Opal Fields. Drawn from nature by Mr. F. R. Leggatt.



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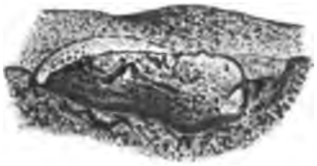

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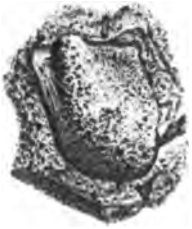

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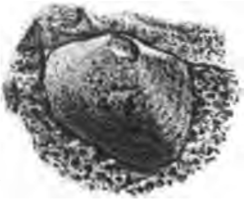

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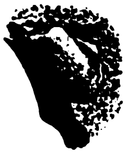

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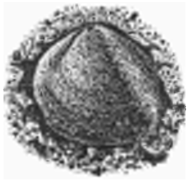

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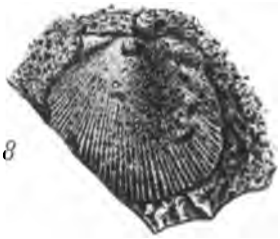

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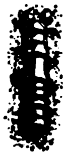

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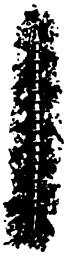

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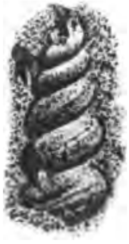

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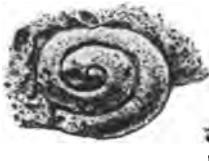

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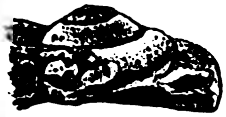

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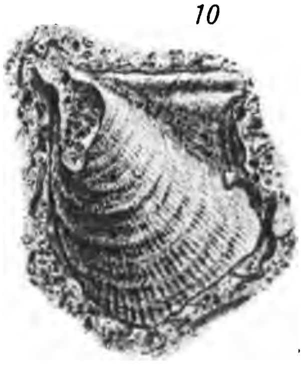

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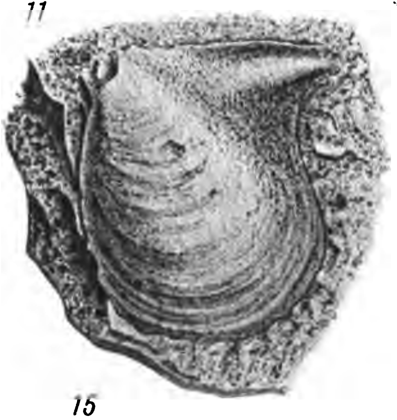

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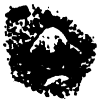

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Frank R. Leggatt, del.

PLATE XIX.

Dielasma inversa, *De Koninck, sp.*

Fig. 1. Side view of united valves. Harper's Hill.
Fig. 2. Dorsal view of Fig. 1.
Fig. 3. Ventral view of Fig. 1.
Fig. 4. Side view of another specimen. W. Maitland.
Fig. 5. Dorsal view of Fig. 4, with slit left by the septum.
Fig. 6. Ventral view of Fig. 4.
Fig. 7. A broader variety, dorsal view. W. Maitland.
Fig. 8. Ventral view of Fig. 7.
Fig. 9. Side view of Fig. 7, showing the lateral curvature of the dorsal valve.
Fig. 10. Dorsal view, showing cavities left by the dental plates and impression of muscular platform, &c. W. Maitland.
Fig. 11. Wax impression taken from Fig. 10, with the muscular platform well shown.
Fig. 12. Side view of an elongated variety resembling De Koninck's figure. West Maitland.
Fig. 13. Dorsal view of Fig. 12.

Platyschisma oculus, *J. de C. Sowerby, sp.*

Fig. 14. Back view of a depressed variety, with only two whorls seen in a side view. Harper's Hill.
Fig. 15. Front view of Fig. 14, with the umbilicus visable.
Fig. 16. View of the base of Fig. 14, displaying the delicate cancellation of the surface.
Fig. 17. The obtuse peripheral keel of Fig. 14, magnified, exhibiting the backward flexure of the oblique threads.

Actinoconchus planosulcatus, *Phillips, sp.*

Fig. 18. A valve partially embedded in matrix with portions of two of the calcareous laminar plates and their component spines, enlarged. Dungog Road.

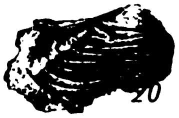
Leiopteria ? australis, *Eth. fil.*

Fig. 19. Left valve, internal cast. Dungog Road.

Leptodomus duplicicosta, *Eth. fil.*

Fig. 20. Side view of a right valve displaying the bifurcate costæ. Maitland Colliery.
Fig. 21. Dorsal view of Fig. 20.

Drawn from nature by Messrs. P. T. Hammond and F. Leggatt.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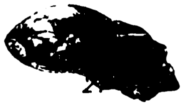
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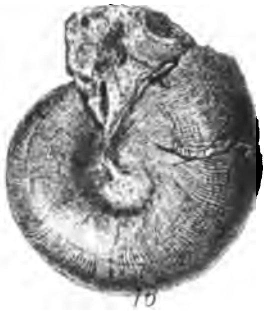
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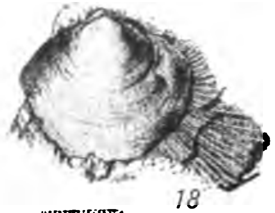
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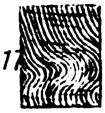
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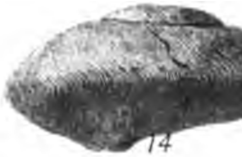
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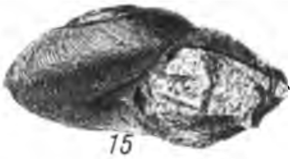
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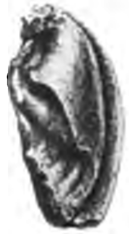

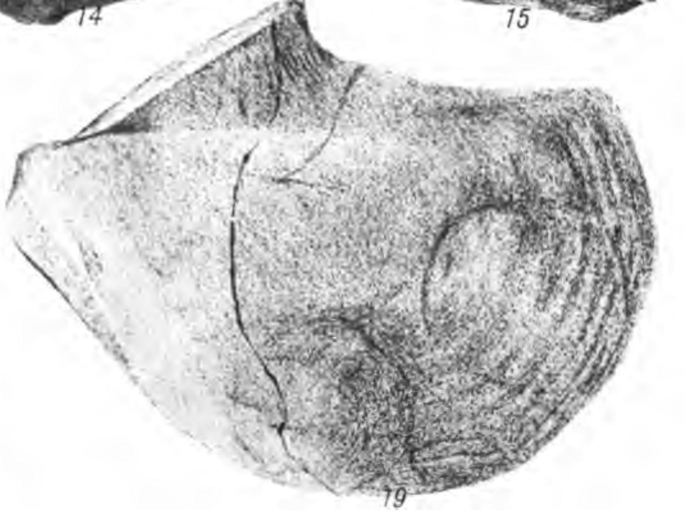
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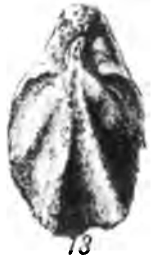
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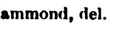
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GEOLOGICAL MAPS AND PUBLICATIONS ISSUED BY THE DEPARTMENT OF MINES AND AGRICULTURE, SYDNEY.

(1.) MAPS.

Map showing Mineral Areas of New South Wales. Scale, 16 miles to 1 inch.
Do do do Scale, 50 miles to 1 inch.
Geological Sketch Map of New South Wales, compiled from the Maps of the late Rev. W. B. Clarke, M.A., F.R.S., by C. S. Wilkinson, L.S., F.G.S., Government Geological Surveyor-in-charge. Scale, 8 miles to 1 inch.
Do do do do Scale, 22 miles to 1 inch.
Do do do prepared under the direction of E. F. Pittman, &c., &c., Government Geologist. Scale, 16 miles to 1 inch.
Geological Map of the Districts of Hartley, Bowenfells, Wallerawang, and Rydal, by C. S. Wilkinson, L.S., F.G.S.
Geological Map of Hill End and Tambaroora, by E. F. Pittman, Geological Surveyor.
Geological Map of the Vegetable Creek Tin-mining District, by T. W. E. David, B.A., F.G.S., Geological Surveyor. Scale, 58 chains to 1 inch.
Index Map of the Vegetable Creek Tin-fields, by T. W. E. David, B.A., F.G.S. Scale, 80 chains to 1 inch.
Geological Map of the Forest Reefs District, by H. Y. L. Brown, Geological Surveyor.
Map of the Silver-mining Country, Barrier Ranges, by C. S. Wilkinson, L.S., F.G.S.
Vertical Sections of New South Wales Upper Coal Measures, by John Mackenzie, F.G.S., Examiner of Coal-fields.
Diagrams showing the Thickness, Character, and Portion mined out of Coal-seams in the Coal Measures of New South Wales, by John Mackenzie, F.G.S., Examiner of Coal-fields.
Plans showing the Outcrop, Thickness, and Dip of the Coal-seams in the Northern, Southern, and Western Coal-mining Districts of New South Wales, by John Mackenzie, F.G.S., Examiner of Coal-fields.
Geological Sketch Map showing boundary of the Cretaceo-Tertiary Formation in the County of Cowper, by William Anderson, Geological Surveyor, 1889.
Geological Sketch Map of Tertiary Deep Lead, Tumberumba, by William Anderson, 1890.
Sketch Map showing Geological Features between Peak Hill and Tomingley, by William Anderson, 1890.
Geological Map showing the principal Stanniferous Leads in the Tingha and Elsmore Districts, by the late C. S. Wilkinson, F.G.S., F.L.S., and T. W. E. David, B.A., F.G.S., 1895.

(2.) PUBLICATIONS.

The Mining Act of 1881, with Regulations.
Annual Reports from 1875 to 1896 inclusive.
Mines and Mineral Statistics, 1875. [Out of print.]
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1. Mineral Products of New South Wales, by Harrie Wood, J.P., Under Secretary for Mines.
2. Notes on the Geology of New South Wales, by C. S. Wilkinson, L.S., F.G.S., Geological Surveyor-in-Charge.
3. Description of the Minerals of New South Wales, by Archibald Liversidge, M.A., F.R.S., F.C.S., F.G.S., &c., Professor of Chemistry and Mineralogy in the University of Sydney.
4. Catalogue of Works, Papers, Reports, and Maps on the Geology, Palæontology, Mineralogy, &c., &c., of the Australian Continent and Tasmania, by Robert Etheridge, Junr., of the British Museum, and Robert Logan Ja F.R.G.S., F.G.S., Government Geologist for Queensland.

MINERAL PRODUCTS OF NEW SOUTH WALES, 2nd Edition, 1886, containing :— [Out of print.]
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